Sveriges lantbruksuniversitet
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Municipal stormwater management in Denmark

A socio-environmental study of municipal water managers' praxis

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Preface

In the auspices of the strategic partnership *Vand i byer,* in English "Water in Cities", more than 150 partners have initiated an innovation project named *Regn med kvalitet*, in English "Rain with quality", as the innovation project No. 10. The consortium consists of a group of science institutions (University of Copenhagen, Danish Technical University, Geological survey of Denmark and Greenland, Danish Hydrological Institute, Danish Technological Institute) including a number of environmental authorities, utility companies and manufactures of treatment technologies. Together they seek to gain an improved understanding of the management of polluted urban stormwater. Through the project, the consortium attempts to answer the following three questions:

1) How polluted is stormwater runoff?
2) Which technologies exist for the treatment of stormwater runoff?
3) Which requirements should be set for infiltration- and discharge facilities?

The present study is made in connection to the *Water in Cities* consortium and seeks to acquire more information on how the case handling for stormwater discharge to receiving waters is carried out today.
This thesis is addressed to any water-professional on any institutional level, academic, NGO and not least citizen who is interested in gaining insight into the current practice as well as understanding the role of stormwater discharge in the compliance process of politically fixed objectives for the aquatic environment. As the Water Framework Directive (WFD) driven water management is fairly new, it can provide water-professionals, both governmental and private, an idea of status quo and insight into areas that need attention in the WFD's cyclic management process.

Acknowledgements

Many thanks to

Simon Toft Ingvertsen from KU-Science and Lotten Westberg from SLU for helping me to get started in the beginning of the process.

My supervisor at KU-Science Lasse Baaner, whom I could meet with in person as we both reside in DK. Thanks for always topping your support with a smile and a laugh. It means a lot for a student.

My supervisor at SLU Antoienette Wärnbäck, for following me in the final stages and guiding me to make my thesis turn out right.

To all the water managers from the Danish municipalities who participated in my interviews and shared their experiences and reflections with me. I hope this study will contribute to a greater context in shedding light on the challenges that lie in your work of balancing stormwater management with environmental protection.

Det største kys til Maryam, Erik og Eliot - fordi I altid er der.

Marziyeh Elahi
March 2014

Abstract

This study was motivated by the outlook of climate changes, expectations of more stormwater in the future, and the potential impact of stormwater on receiving waters. The study set out to investigate how Danish municipalities balance stormwater management with environmental objectives as set out by the WFD and national law. The general aim was to understand if the current stormwater management practice could impede compliance with environmental objectives.

After an outline of the legal frames for the practice, an interview study about the practice, with seven municipal water managers from four different municipalities, who process discharge permits, was carried out. The qualitative data was analysed through a practice theoretical perspective in order to understand the water managers' way of reasoning and how they balance the need of stormwater discharge with environmental objectives.

Some of the main impediments to compliance with environmental objectives were found to be lack of environmental data on receiving waters and a lack of knowledge about the pollution profile of stormwater. These two elements have created a practice where a low-tech treatment/delay facility is required in permits but no further consistent monitoring of the discharge is carried out. However, uncertainties remain about the efficiency of available technology and whether the use of the technologies perceived as Best Available Technology (BAT) is sufficient to comply with environmental objectives.

Keywords: Stormwater management, Stormwater discharge, WFD, Environmental Objectives, Practice Theory, Theory of Structuration, SUDS, BAT.

Abbreviations

APAE: Danish Action Plan for the Aquatic Environment

BAP: Best Available Practice

BAT: Best Available Technology

CSO: Combined Sewer Overflows

DVFI: Dansk Vandløbs Fauna Indeks (Danish Stream Fauna Index)

EOA: Environmental Objectives Act

EPA: Environmental Protection Act

EQS[1]: Environmental Quality Standards

WFD: The European Water Framework Directive

XOC: Xenobiotic Organic Compounds

Clarification of concepts

Condition: This word is used synonymously with the words *term* and *requirement* in relation to discharge permits.

Stormwater runoff: Rainwater or snow that has hit roof or road surfaces. Used synonymously with *urban runoff*.

Water manager: The municipal case handler who handles the assessment of a discharge application and announces either an authorisation or refusal. The term is used synonymously with *respondent.*

Basin/Wet pond: A small lake where delay and treatment of the stormwater can take place before final discharge. Can be either underground or placed on the surface as both natural- and artificial lakes. In a Danish context most often referred to as basin

[1] Environmental quality standard here refers to the concentration of a particular pollutant or group of pollutants in water, sediment or biota, of a watercourse, which should not be exceeded in order to protect human health and the environment cf. the WFD.

Contents

1 Introduction

Parts of Europe are becoming increasingly exposed to cloudbursts, which is much likely a result of climate changes, and the Inter Governmental Panel on Climate Change foresees more intensive summertime precipitation for northern Europe and Denmark (DMI, 2012). The changes in the precipitation patterns, experienced today, in periods put an overload of pressure on the sewage systems, causing flooding and structural damage in Danish cities. In Denmark, overflow basins for combined sewers have been used as buffers, allowing for combined sewer overflow (CSO), during heavy showers. Discharge of untreated storm- and sewage water from CSO usually releases a range of pollutants to the receiving water body. CSO can cause rapid depletion of oxygen levels, a health indicator of aquatic environments, in the receiving waterways (Even et al., 2007) as well as an impediment in reaching goals of good status for water bodies as set by the WFD (Johansen et al., 2007). The same overflow events occur from separate sewers[2] in time of storm, if delay or treatment of the water does not take place. Even though the water is not polluted in the same way as sanitary water from combined sewers, it can cause pollution of the receiving water - and erosion problems if the water body is a stream (Walsh et al., 2005). Walsh et al. recognise a so-called 'urban stream syndrome' as a consistently observed ecological degradation of streams draining urban land. The predominant mechanism driving the syndrome is indicated as urban stormwater runoff led to receiving waters (ibid). Runoff may seem unpolluted, but as it hits surfaces such as roofs, roads and parking lots, it will often become polluted from a build-up of several contaminant groups. Ingvertsen et al. (2011a) in a review classify the most relevant pollutants into five key groups. In figure 1, these groups and their possible effects on aquatic environments are pointed out. As a result of the EU's WFD, which obliges member countries to reach a good ecological status in water bodies, stringent requirements to the quality of the stormwater is set. It means that the urban run off must be treated somehow, if environmental objectives are to be met (Ingvertsen et. al., 2010). Today, low-tech treatment facilities, such as oil separators and grid chambers[3] are employed for this purpose. Because of the foreseen cloudburst, researchers, technical consultants and utilities have turned their attention towards the so-called Sustainable Urban Drainage Systems (SUDS)[4], as a supplement to the sewer system, with the aim of making cities more climate proof. SUDS, which are also perceived as low-tech facilities, allow for part of the stormwater to be managed in the urban landscape through delay and thereafter infiltration to groundwater, or delay and then drainage to a stream, lake or the sea. However, the challenge remains in documenting the treatment efficiency of SUDS and other treatment facilities. Allison et al. (2008) point to the lack of adequate performance data on SUDS, in various settings, as an implementation barrier to the technology. Likewise Ingvertsen et al. propound the difficulty of properly benchmarking the technology because of big differences in international data on the pollutant profile of run off and a lack of standardisation of sampling and analysis. This situation leaves a question of how authorities who permit stormwater discharge assess what BAT is for treatment and delay of run off. A need of national guidelines to harmonise future evaluation of low-tech treatment facilities and tools for the decision-making on the requirements to set to the quality of

[2] For an overview of the urban sewer system see appendix 1.

[3] A low-tech treatment facility the stormwater runs trough, which sieves or filters the sediment in the water.

[4] For a short introduction to SUDS see appendix 2.

the stormwater and documentation of the treatment facility is according to Ingvertsen et al. needed in the work of stormwater managers - both on private and public levels.

During time, environmental authorities in Denmark have given thousands of permits for discharge of untreated stormwater from separate sewer systems to receiving water bodies (Baaner 2013a, Personal communication) and the recent Danish municipal plans on climate adaptation mean that more stormwater will likely be managed through infiltration and discharge to receiving water waters by e.g. the use of SUDS. At the same time Denmark must obtain good status in its water bodies, as set out by the WFD. Stormwater's impact potential on receiving waters focus itself as a management that needs attention in reaching the objectives of the WFD. Söderberg (2011) found that the Swedish legal system could not guarantee a stormwater management in accordance with legal demands set by the EU because the possibilities for regulation in Swedish law were not made use of in practice by authorities. This was i.a. a result of imprecise provisions and weak rules on implementation of environmental quality standards and programmes of measures. Söderberg also found the lack of knowledge about the environmental impacts of stormwater as a reason to the relaxed management.

It is likely that Danish authorities are faced with the same administrative challenges that Sjöberg propounds, but no other Danish study has clarified the stormwater management praxis in relation to EU stipulated environmental objectives. Hence in extension to the above outlined problematics this study, through a qualitative research method, namely an interview study, looks into the actual municipal stormwater management. As it is municipalities who have the responsibility to permit stormwater discharge as well as achieving environmental goals, the focus is put on municipal water managers' practice. Through a practice theoretical perspective, their practice is analysed in order to properly understand their way of reasoning and decision-making process as well as any conditions in their praxis that could hinder achievement of environmental objectives for receiving waters. In order to make this analysis, a solid understanding of the regulative aspects influencing stormwater management is needed as part of a validation of the quality data. Thus an outline and problematisation of the legal frames, underpinning stormwater management, will be the launch pad of this thesis.

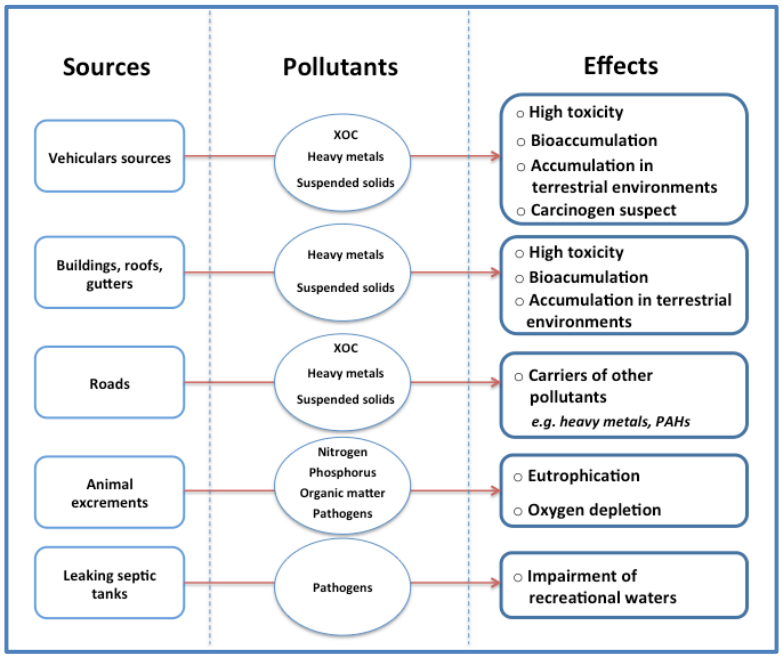

Figure 1. Key contaminant groups in urban runoff and their possible adverse effects on aquatic environments. (After Ingvertsen et al.,2011a)

1.1 Objectives

The general aim of this thesis is to contribute with insight to the current stormwater management praxis in order to understand which impediments there might be in the way of achieving environmental objectives of the water environment. This focus falls within a socio-institutional frame, influenced by political, legal, managerial and administrative forces. The research-inquiry itself will centre on the Danish municipal authorities' management praxis for discharge permits, as it is they who are the responsible for granting stormwater discharge permissions.

The specific questions to uncover are:

1) Which provisions of the WFD and other relevant national acts that can influence their decision-making can and do authorities recognise and implement?

2) How do authorities reason which kind of requirement to set in the discharge permit on grounds of environmental objectives?

3) Where do the authorities learn about BAT for stormwater discharge and what is their perception of BAT at the moment?

4) How is the consideration for climate adaption balanced against the consideration for the water environment when granting a concrete permit?

1.2 Structure of thesis

This thesis starts out by outlining the frames, which have been created to underpin the current stormwater management paradigms as well as the historical influence on it, and hereafter elucidates the practise itself as result of these frames. This study therefore draws on several disciplines in seeking to cover the interaction between the environmental science and legal disciplines, unfolded in an administrative practice as the background. This practice is then analysed through a sociological practice theoretical perspective - remaining the core of the thesis. Insight into all mentioned disciplines is thus needed for an overall comprehension of the practice (figure 2 illustrates the cross field of the disciplines integrated in this study). Accordingly, this study, in the below, order works its way through the problematised areas to provide insight and finally offer clarification in response to the main objectives of this study.

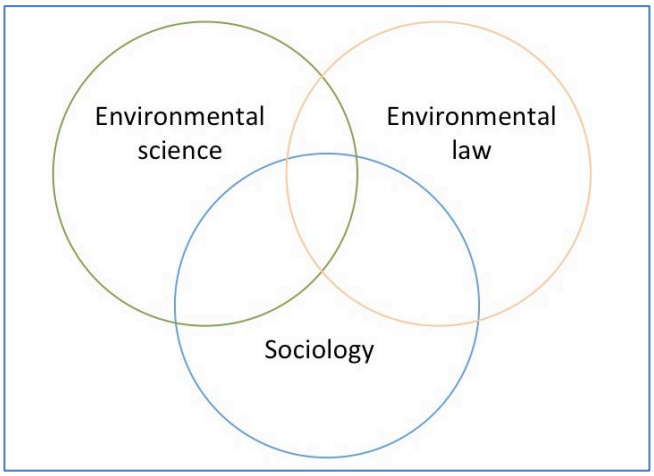

Figure 2. The cross field of the integrated disciplines together providing a clearer picture of the problem.

1. Starting with a retrospect, the current stormwater management in Denmark is described briefly, to allow for an understanding of status quo and the historical influence on it.
2. Hereafter an analysis and problematisation of regulative aspects, both on EU and national levels, which underpin the current stormwater management, is made and summarised.
3. Then a short introduction to authorities' assessment procedure of discharge applications is given.
4. Thereafter, a brief presentation of Danish climate adaptation plans and its implication on the future stormwater management in Denmark is outlined.
5. The epistemological approach of the qualitative study is motivated and the theoretical frame chosen as a means to analyse and understand the practice of water managers is described.
6. Choices of method including collection of empirical data are defined. As a natural continuation of the chapter on methods, an evaluation of the method in relation to the derived results is given in this chapter rather than in the discussion.
7. Grounded in the epistemological approach and chosen theory, an analysis of the empirical data will be presented.
8. Finally the essential results from the analysis will be discussed while integrating other studies to offer a frame of reference and other perspectives.

2 Stormwater management – legal frames and praxis

Water management can be phrased as political will and strategies implemented in legal basis, which are again implemented in action plans, containing goals and programs of measures. These plans are then to be realised through concrete actions becoming part of an on-going practice. This chapter is meant to give a presentation of the mentioned levels, which could potentially contain impediments to their self-same goals.

2.1 Stormwater management in a national and regional planning retrospect

Through times, the Danish wastewater management was aimed at preventing human contact with wastewater in order to avoid diseases. Starting in 1970's, focus was also put on the consequences wastewater had on the natural environment. In the last 30 years, the load of nutrient salts of nitrogen (N) and phosphorous (P) and the adverse effect they have on receiving waterways have caught attention. As a result of continuous oxygen depletion in the bays and coastal waters in the 1980's, the Danish parliament enacted the first Danish Action Plan for the Aquatic Environment. This political agreement contained politically stipulated reductions of pollutants to the aquatic environment in general. In the case of wastewater, the plan indicated maximum values of discharge of nutrient salts of N and P and measured biochemical oxygen demand (Danish EPA, 2003). The results of the plan were a decrease in impact through improved wastewater treatment, more stringent discharge conditions and implementation of delay basins to reduce CSO. Arnbjerg-Nielsen & Johansen (2002) note that between 1975-1990 there was great awareness about stormwater runoff and their effect on small local streams and lakes. In particular, the impact from CSO was big. Despite this awareness, the actions as result of the Action Plan for the Aquatic Environment were mainly directed towards the biggest pollutants of the coastal environment, namely N and P. More specifically, mass balances showed that significant reductions of nutrient salts could be gained through biological treatment plants, and thus resources were spent on these. Discharge of separated stormwater became less of a priority and was left to the management of the former county authorities[5]. With no detailed guidelines on stormwater management, big differences in the actual conditions and terms for stormwater discharge became a reality (ibid).

Denmark issued its first plans on regional level in 1980, the so-called *Regional plans* and from 1985 objectives for receiving waterways were established in these plans (Danish Nature Agency, 2004). The county authorities issuing the Regional plans and monitoring the effects of the stormwater discharge found that the impact was still often unacceptable compared to their objectives for the receiving waters (Arnbjerg-Nielsen & Johansen, 2002). Some improvements were made, but from 2000 the focus was on implementation of the new management and planning scheme arising from the WFD. From 2003 this task was attributed the counties – however the counties were abolished in a municipal reform of 2007. In connection to the structural reform and abolishment of the counties, the Regional

[5] From 1970, Denmark consisted of 275 municipalities and 14 county authorities. In 2007 the administrative structure was changed to 5 regions and 98 big municipalities - hereby the counties where abolished (Region Sjælland, n.d).

Plans were attributed legal effect as statutory orders. The Regional Plans are – for the field of water management – thereby upheld until the Danish river basin management plans, as conditioned by the WFD, become effective (Danish Nature Agency, 2011). See figure 3 for a temporal overview of integration of new acts.

The historically low political profile of stormwater management, as described above, reveals itself as a barrier, to a management with focus on environmental objectives, if the current practice is an extension of the course of history.

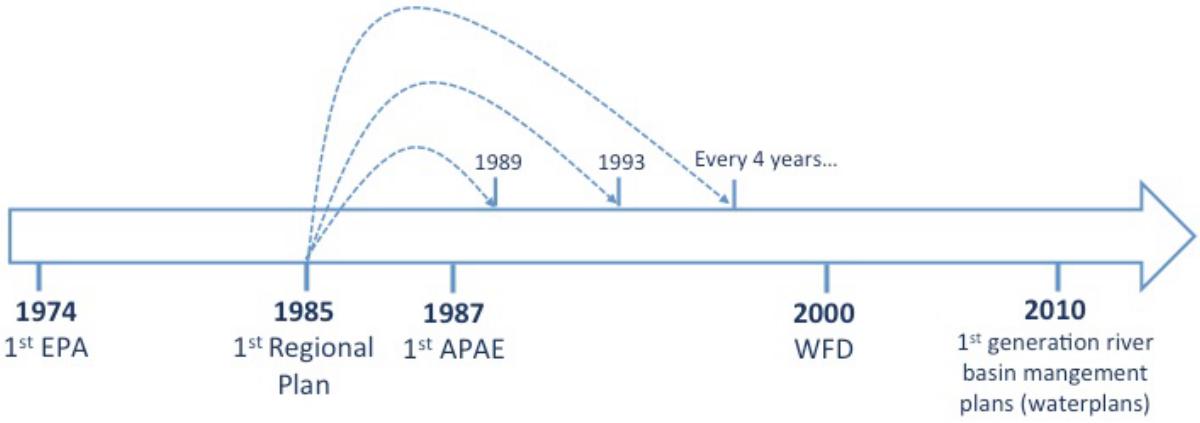

Figure 3. Timeline providing an overview of the integration of new environmental acts, starting with the first Danish Environmental Protection Act in 1974.

2.2 The WFD – root of discharge regulation

Through interplay, several laws appoint requirements for protection and amelioration of water bodies in Denmark. In the discharge authorisation context, the point of departure will be the European WFD[6] Art. 10 – the combined approach. This is an effort to illustrate how regulation, affecting stormwater discharge, disseminates from European to national level. EU regulation, including the WFD, is transposed into Danish law through, inter alia, river basin management plans that shall contain the more detailed environmental objectives for waterways, as stipulated by the WFD.
The WFD's two direct applicable implements on surface water bodies are the *environmental objectives* and Art. 10 the so-called *combined approach*. By transposition into national law, these tools become the most essential legal obligations.

Environmental objectives and environmental quality standards
The first two relevant provisions of the WFD within the discharge circumstance are as listed:

- Environmental objectives
- Environmental quality standards

The WFD takes on a watershed approach aiming at good water status for each catchment area, in the sense that measures for surface waters and ground water that belong to the same ecological, hydrological and hydrogeological system are harmonised as it appears in preamble 33 of the WFD. The directive is based on binding *environmental objectives* to be achieved within specific timeframes. The WFD Art. 4 assigns, environmental objectives as "good ecological and chemical status" for all surface water bodies in the European community by 2015. These objectives are then broken down into measurable biological, hydro-morphological and physiochemical quality elements that shall be lived up to, in order for a water body to obtain a 'good status'. Each member must ensure that the environmental objectives can be fulfilled. A constituting part of achieving the environmental objectives, which the directive operates with, are fixed *environmental quality standards* (EQS), which are meant to regulate the chemical status of a watercourse. In the directive, the quality standards are defined as *"Environmental quality standard means the concentration of a particular pollutant or group of pollutants in water, sediment or biota, of the watercourse, which should not be exceeded in order to protect human health and the environment."* cf. article 2 (35) and annex V of the WFD.
Discharge to surface waters shall take the environmental objectives of the receiving water into consideration. An assessment of whether a concrete discharge can affect the quality elements that together determine the ecological status and the EQS, which determines chemical status, shall be carried out (Baaner, 2013b).
EU directive 2008/105 sets EQS, for 33 priority substances, in the field of water policy.

[6] Directive/2000/60/EC

WFD Article 10 – the combined approach

The WFD Art. 10 encompasses the last two significant provisions for discharge to surface waters through:

- Emission controls
- Conditions

The WFD Art. 10 stipulates the regulation of discharge from point- and diffuse sources through a combined approach. The WFD Art. 10(2) prescribes that emission of pollutants to an aquatic environment is to be restricted by means of emission controls through a combination of either:

a) Emission control based on BAT or
b) Relevant emission limit values or
c) In case of diffuse impact, controls including the application of Best Applicable Technology (BAP), where it is appropriate

Furthermore, WFD Art. 10(3) provides that if conditions of § 2 are not sufficient to live up to quality objectives and EQS for a specific water body, set in any valid directive, *conditions* as in more stringent emission controls for the discharge shall be set.

To sum up the function of WFD Art. 10 and the combined approach: discharge permits must require the use of BAT and for diffuse sources, an application of BAP. This means that either a) there must be a technical measure (BAT) applied, that can treat the stormwater to a certain degree or b) the stormwater, before discharge, can live up to fixed pollution thresholds. If it is assessed that application of either a or b are not sufficient enough for the receiving water body to live up to its own pollution thresholds (i.e. the EQS), the competent authority, dealing with the authorisation, must set terms of more rigid emission controls for the stormwater to be discharged. Said in another way, an authorisation for discharge must ensure that a water body will not exceed its quality objectives, which comprise the EQS.

WFD Art. 10 is included as an element in this study as it is directly linked to discharge. The aim is to acquire insight into authorities' practice and how they assure that pollution thresholds (EQS) for the respective water body are not exceeded.
BAT, being best available technology, can be perceived as a vague concept, as basically it cannot stay static. As the word implies, it is the best technology available presently, but it could well be another tomorrow. Therefore, questions arise on:

- How is stipulation of emission limit values and BAT balanced?
- What *is* BAT within stormwater discharge?
- How do authorities learn what BAT is within their field?

2.3 Transposition of the WFD into Danish law

The Danish Environmental Objectives Act (EOA) implements the WFD in Danish law. The EOA sets the legal framework for the protection and management of ground and surface water and also the planning within international nature protection areas. The EOA § 11 states that deterioration of all surface water and groundwater bodies shall be prevented, which is in line with what the WFD stipulates. According to (Baaner & Anker, 2012), this means that a water body shall not, as a result of activities or projects, fall into a lower status class than it was originally assessed to have.
The EOA § 3 stipulates preparation of national river basin management plans, which account for, how Denmark shall obtain the objectives of the WFD. The Danish government has chosen to call these management plans for *water plans*. The water plans shall set explicit objectives for specific water bodies within the different water districts. Statutory Order 1433/2009 on *appointment of environmental objectives for streams, lakes, coastal water, estuaries and groundwater* sets out the rules for the specification of reference status and environmental objectives and likewise provides definitions of 'good status' for water bodies, including the quality elements as referred to in section 2.2.

Appertaining national programs of measures, as outlined in WFD Art. 11, specify how the goals in the water plans will be met. The Minister of Environment together with The Danish Nature Agency have the responsibility to create the plans. The plans integrate water quality planning as well as water resource planning for 23 water districts in Denmark. The first generation water plans have been delayed for about four years and have been in public hearing until December 2013, meaning that the draft versions of them are official, but they are still to be enacted (Danish Nature Agency, 2013a). Denmark has not complied with the implementation process and as the water plans have been delayed, updated environmental objectives for water bodies have been unclear up until the second proposal publication of the water plans. This has meant that the objectives for the specified water bodies have been unknown, thus not applicable for the administration of authorities for a part of the first 6-year period of the WFD's management cycle started in 2009 and ending in 2015 (Baaner, 2012). The outlined problematic prompts a need of clarification on which guidelines municipal authorities currently apply in their work with stormwater, in the absence of enacted water plans.
In terms of guidelines on stormwater discharge the water plans as a general guideline for all water districts recommend the use of basins (wet ponds) of proper size as a mean to trap sediment. In terms of design and dimensioning of basins it is stated in guideline no. nine:

"Where there is risk of hydraulic problems, stormwater discharges shall generally be reduced to 1-2 l/s/hectare (total area) corresponding to natural flow[7]. Basins at both separate sewer discharge points as well as CSO, shall in these situations have a size so that in average overflow only takes place every 5th year [..]. In terms of the design of basins for stormwater reference is made to wastewater research from the Environmental Agency no. 49/1992." (Danish Nature Agency, 2011:55)

[7] It is assumed that this is a reference to the natural flow of the receiving water, e.g. a stream.

The guideline stipulates a maximum discharge flow to the receiving water and a number of maximum overflow incidents. In terms of basin design, it can seem odd that a reference is made to guidelines found in a report from 1992, seen in the light of the requirement of BAT in stormwater regulation.

In the near future, when the national water plans are promulgated, all municipal councils shall, as the next step, draw up municipal action plans. Through the municipal action plans, municipalities will state how they will actualise the water plans and its programmes of measures within their own region. Moreover municipal sector plans, consisting of water supply plans and wastewater plans, will also be updated and managed in accordance to the water plans and its program of measures (Danish Nature Agency, 2013b). Figure 4 was made to provide a quick overview of the relevant laws mentioned. Law on watercourses is included in the figure, as the physical state of a stream must not be modified according to this law, which is relevant in terms of discharge. The Nature Protection Act is included in the figure, as protected nature areas, included in § 3 of the law, shall not undergo modification as a result of a discharge.

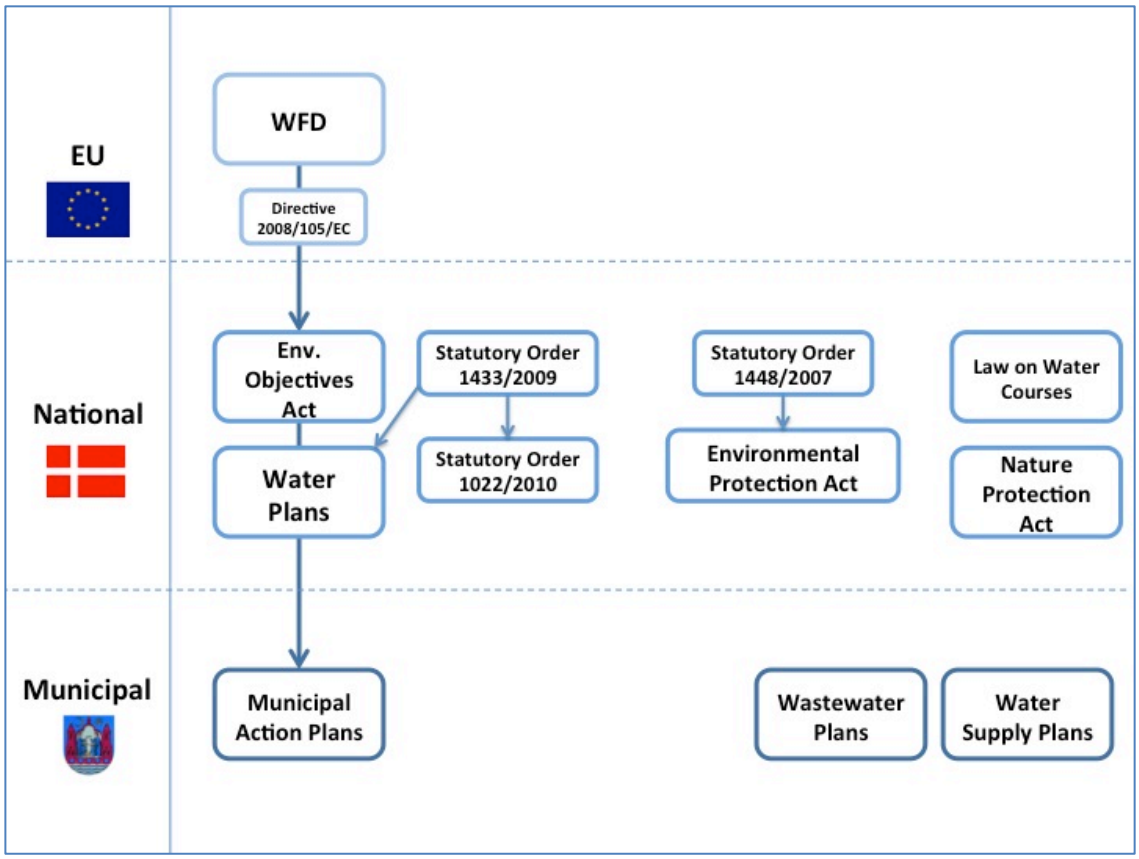

Figure 4. Overview of regional and national laws that regulate stormwater management. An arrow indicates their direct relations.

2.4 Danish regulation of wastewater discharge

In a legal sense, rainwater becomes wastewater, thus a source of pollution, when it hits any fortified surface according to the Statutory Order on Waste Water Permits 1448/2007 § 4(3). Therefore the discharge of it to any water body must be regulated by discharge permission.

The Environmental Protection Act particularly (EPA) centres on prevention and combat of pollution of air, water, soil and subsoil resources. Wastewater discharge to receiving water bodies is regulated with a requirement of obtaining authorisation in order to discharge pollutants to aquatic environments. The EPA §§ 27-28, set the legal framework for this regulation. The EPA § 27 states that compounds, including wastewater, which can pollute water, shall not be discharged to streams, lakes or the sea. The EPA § 28 (1) makes an exemption for wastewater and states that municipal councils can grant permits for the discharge of wastewater to streams, lakes or the sea. The procedure today is that an environmental section of the municipality handles the permit authorisation. Pursuant to the EPA § 29, requirements can be set for the treatment of wastewater and so can further terms in relation to the discharge permits pursuant to the EPA § 28.
The EPA § 3 requires that by application of the law, emphasis must be on achievable pollution prevention through the use of BAT.

Statutory order 1022/2010 on environmental quality standards

Another piece of law regulation with an impact on discharge of wastewater is Danish Statutory Order 1022/2010 on environmental quality standards for water bodies and conditions for discharge of polluting compounds to streams, lakes and the coast.
Statutory Order 1022/2010 implements provisions of EU directive 2008/105 on environmental quality standards, EU directive 2006/11[8] on discharge of pollutants to the community's water environment as well as the WFD. This means that Statutory Order 1022/2010 implements the WFD's environmental objectives and the associated EQS.
On a national level, Statutory Order 1433/2009 on *appointment of environmental objectives* stipulates that EQS as set in Order 1022/2010 must be met in order for a water body to reach 'good status'.
Statutory Order 1022/2010 appoints EQS for priority substances as well as further regulation on discharge of polluting substances, including wastewater to water bodies. However, Order 1022/2010 § 1 formally excludes stormwater from its provisions - meaning that it does not regulate the authorisation of stormwater discharge. Nevertheless, because of its close connection to environmental objectives of the WFD, Order 1022/2010 and its listed EQS values become binding for municipalities also when issuing stormwater discharge permits (Baaner, 2013). This means that authorities must, when issuing a stormwater permit, ensure that the receiving water's EQS can be met.
In Statutory Order 1022/2010 § 13, the application of Art. 10 of the WFD, is required for discharge to a receiving water or area, which is also in accordance to the EPA § 3 (see section 2.4). This means that a permit must not be given unless BAT has been required as technical facility and if BAT is not sufficient, further requirements of emission control must take place. However, there are no legally (and official)

[8] Directive 2006/11 has expired 22nd of December 2013 as of WFD Art. 22 (3). The programmes for reduction of pollutants are instead replaced by Programmes of Measures as of the WFD Art. 11.

fixed emission limit values for stormwater as it is today. This means that if authorities wish to control through emission limit values, in order to live up to EQS, they would have to procure these emission limit values themselves.
A complicated situation appears, partly also because of the formal exclusion of stormwater in Order 1022/2010 that can create a grey zone for regulation on municipal level and can make the situation somewhat ambiguous for authorities. Therefore it is relevant to investigate by which guidelines authorities regulate polluting compounds when processing permits and whether they require BAT, and if they know whether the BAT they require can live up to the emission limit values relevant to ensure compliance with the EQS for a water body with environmental objectives.

2.5 Environmental data on receiving waterways

In this section a description of where authorities find data on receiving waters, used as basis in the assessment of discharge applications, is given.

The sensitiveness of a receiving waterway is central for the delay-time and treatment of what will be discharged to it. Hence, it becomes fundamental that a water manager can base his assessment of a discharge on representative data about the status and environmental objectives for a respective receiving waterway. The catchment area, from which the stormwater runoff drains, is likewise important to assess. The traffic load of a road and the interval of rainy days will have an impact on how much pollution is built up and how much eventually flows away with the runoff (Vollertsen et al., 2012). Likewise the catchments' imperviousness will affect the discharge flow - where higher degrees of imperviousness results in a more efficient transport of runoff (Walsh et al., 2005). According to Battrup-Pedersen et al. (2004) pulse events, caused e.g. by a storm, can be problematic for streams in terms of the nitrogen and phosphorous content of the water. In particular, it can be problematic for streams where the flow is low and hence so will the dilution of the discharge be.
From the ground, the runoff can pick up suspended solids in the form of sediment, trash, debris, asphalt, and animal excrements - especially from birds. Zinc and copper roofs are a significant source of heavy metals in the water. Further, abrasion of buildings and vehicular parts also contribute with heavy metals. Both exhaust and engine oil add to the contaminant profile with xenobiotic organic compounds (XOCs) i.e. PAHs. Finally, pesticides used in urban areas are also a source of XOC (Ingvertsen et al., 2011a). Battrup-Pedersen et al. (2004) also point out that XOC, heavy metals etc. can affect the chemical state of the sediment some distance downstream from the outlet. In summary, knowledge on the chemical, biological and hydrological[9] status of the respective water body is needed when assessing a prospective discharge and its environmental impact, and so is knowledge about the catchment from which the runoff drains.

While waiting for the water plans to be adopted, environmental authorities have so far had the Regional Plans and their appertaining plans on water bodies as part of the administration basis for i.a. stormwater discharge. The plans encompass objectives and quality standards for select water bodies

[9] Here referring to the hydrological capacity - including rate of flow and water level.

as featured in a scheme. Guidelines on stormwater discharge are stated, yet very concisely. As an example of the guideline from the recent 2005 Regional Plan of Zealand it is merely stated, *"For stormwater discharge an adequate wet pond (delay basin) size must be ensured so that no unacceptable erosion or pollution will take place"* (Vestsjællands Amt, 2005:7). This guideline is not much more specified in the water plans (see section 2.3).

The data basis for the newer Regional Plans has been the result of former counties monitoring of water bodies included in the national water body surveillance program NOVANA[10] (Vestsjællands Amt, 2005; Svendsen et al., 2004). From the NOVANA reports, authorities can e.g. obtain data on ecological, physical and chemical status of streams. Moreover, an electronic database with an appertaining map feature, as in GIS software, the so-called *Danish Environmental Portal* archives data on water bodies and is likewise available for authorities.

The Danish water plans have as an extra feature, compared to the Regional Plans, integrated the so-called programme of measures, and these are hence available as suggestions for authorities. On the other hand, the environmental objectives for streams are not to be found in the plans. Instead the reader is referred to the ministry's *WebGIS* where all streams with environmental objectives appear and likewise the status of the respective stream, measured at a certain spot. This stream status is apparently representative for about 2 km in average with possibility for divergence (Danish Ministry of Environment, n.d). The water plans appoint environmental objectives for 22,000 km of streams out of a total of 69,000 km of stream length in Denmark, and recommend measures for about 5,000 km, same as 7.2 % of the total stream length. Seemingly more manageable, status and objectives for appointed lakes are integrated in the plans. All lakes over 5 hectares, some between 1-5 hectares and all lakes included in the Natura-2000 designated areas are incorporated. Likewise are status and objectives for coastal waters until 12 nautical miles of distance from the coast (Danish Nature Agency, 2013c).

In the water plans, the present ecological status for streams is given by a biological quality element being the composition of benthic vertebrae in the water. The different species included in the method have different sensitivity levels to pollution degrees. The interrelationship, meaning the distribution levels of the different species (presence or absence), thus indicates the condition of a stream. The method is called Danish Stream Fauna Index (DVFI) and is indicated as fauna classes on a scale from 0-7. In the condition assessments for the fauna classes a status 7 is 'high', 'good' if it is a 5 or 6, moderate if 4 and 'poor' if the fauna class ends on 3, etc. This means that it is the biological quality element that is assessed and used as the primary parameter for the achievement of environmental objectives. For lakes, the ecological status is assessed by the concentration of *chlorophyll a* in the lake - the higher the

[10] NOVANA is the national Danish surveillance programme of the aquatic environment and nature, with the aim of monitoring the status and impacts on the aquatic environment, including streams, lakes and coastal areas, and the development hereof. All NOVANA data up to and including 2006, were collected and provided by the former county employees, current regional units as part of the Danish Nature Agency as well as a number of consultancies on behalf of the counties (Wiber-Larsen, 2011).

concentration, the worse is the status. For coastal waters, the status is primarily assessed by the depth-limit of eelgrass.
In summary, it requires a good scientific basis to be able to assess current status, the achievement of objectives and possible future impacts on the receiving waters.

2.6 Discharge permits

This section briefly presents the current stormwater discharge practice and the municipal work structure within which it is embedded.

The working structure in municipalities
Often, in the environmental division of each Danish municipality, more than one professional deals with stormwater and the processing of a discharge permits. The water managers can have special skills within different fields, e.g. specific knowledge on the assessment of receiving waterways, thus they would carry out this assessment-part. Another water manager then carries out the assessment of e.g. the technical facility and its operation for the discharge project. The water managers work in teams where there is space to share knowledge and parts of the task. It is up to the applicants to provide all necessary information about the discharge project (discharge facility etc.). The water managers treating the application must ensure that the application actually contains adequate information about the water to be discharged, and how it will we done, to enable a proper environmental assessment. In this way, the processing most often becomes a back and forth process between authority and applicant (Personal communication, 2013).
Discharge permits to streams, lakes or the sea are given according to the Environmental Protection Act § 28(1). On the widely used online law portal and legal decision support system *Schultz*, guidelines for authorisation of permits can be found. It is described in the guidelines that applications must be processed with an assessment of the receiving water bodies' objectives, sensitiveness and cost-effective technical possibilities for treatment of the stormwater discharge.

Furthermore it is stated that:
"Setting terms for stormwater discharge is often fairly complicated and relies on, besides factual information, also in many instances professional judgments and assessment". (Schultz, 2014)

Baaner (2013b) writes that the potential impact on all quality elements that together determine a water bodies' ecological and chemical status cf. the WFD, must be considered for every discharge applied for. If a water-professional evaluates that the discharge will prove detrimental to the receiving water, e.g. because of too high quantities of water or a polluted drainage source, the application will result in a refusal. In this case the stormwater is often connected to the sewerage system instead. This is a more expensive solution than using SUDS, as a discharge levy must be paid.

Applicants
Owners or administrators of any settled area can be applicants of storm water discharge permits. It can be private owners of a settled area, but also different municipal administrative sections that

administrate buildings and settled areas. Municipal utility companies[11] who attend to municipal service tasks, including wastewater management, are often applicants of permits. Today, more and more SUDS facilities are integrated in areas where new housings are made, for its drainage abilities, but also because of the amenity value that it brings to the area. Developers or consulting companies, who are advisors on new buildings under construction, including SUDS facilities, are often applicants for storm water drainage permits, as they often also have the competence to assess all aspects of the discharge, including delay and treatment needs. Anyone who needs to discharge stormwater can apply to the respective municipality where the stormwater runoff will take place (Personal communication, 2013).

2.7 Stormwater and climate adaptation

The Danish government has recognised that changing precipitation patterns and outlook of heavier cloudburst are some of the main challenges of climate changes in Denmark (Danish Government, 2012). The water overload caused by cloudbursts often results in overflow of sewers and flooding, especially in low-lying areas, proving detrimental to buildings on ground- and basement level and likewise to the traffic infrastructure. The fact that soil surfaces in cities are becoming increasingly paved, decreases the possibility for the water to infiltrate, and thereby the chance of flooding increases. The expected increase in heavy rain showers is very relevant for the design of urban drainage systems. In many cities today, the main sewerage exists as it was originally projected 100-150 years ago, and shares the underground space with rest of the supply system, such as potable water, electricity- and heating pipes. This organisation makes it almost impossible to restructure the underground sewerage in city centres on a significant- and frequent basis (Arnbjerg-Nielsen, 2006).
One of the latest major cloudbursts in Denmark, causing urban damage, took place in Copenhagen in the summer of 2011, resulting in sewer overflow and flooding in the city. The damage that this flooding left behind has been estimated close on DKK 6 billion by the insurance sector. In order to be proactive and adapt the countries' infrastructure to the changes, Danish municipalities are required to devise climate adaptation plans by the end of 2013 (Danish Nature Agency, 2013d). In these, municipalities provide a risk assessment of flooding, which creates overview, describe how they wish to prioritise measures and set the level for climate adaptation. The climate adaptation plans are guidelines which are made as amendments to municipal plans. This amendment is implemented in municipal wastewater plans as well as district plans (see figure 5). It is in the latter plans that one can find specific measures that municipalities want to carry out as adaptation strategies. By having looked into some of the wastewater plans, it is clear that there is a wish to integrate landscape based stormwater solutions to a higher degree, as a means to deal with the expected floods. The knowledge about the municipalities' wastewater plans, and the proposals of SUDS therein, will be used later on as part of the data collection to understand the influence of climate adaptation on the water managers' work.

[11] The Danish parliament enacted a water sector reform in 2009, which aimed at making the water-and stormwater sector efficient. As part of this reform water supply and stormwater management is now managed in company form. Utility companies consequently became "private" companies.

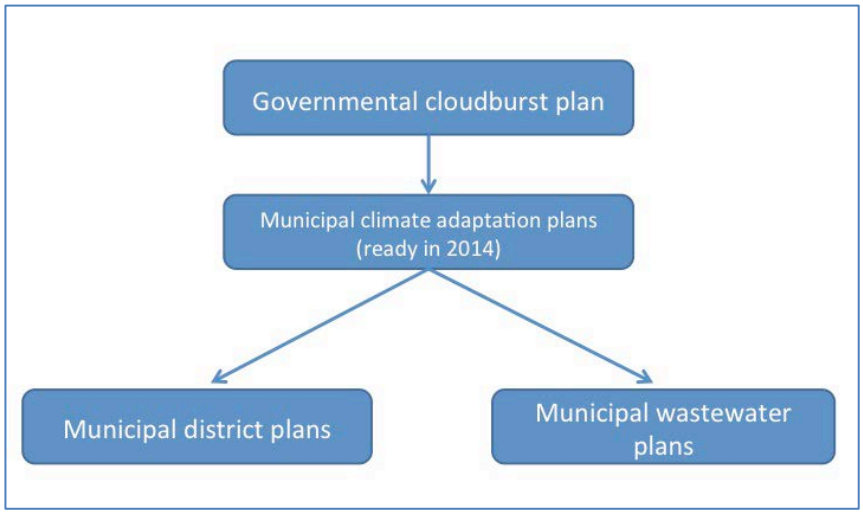

Figure 5. Dissemination of climate strategy and provisions from governmental to municipal plans.

2.8 Summary

Until now an explanation on how discharge permit must be made in terms of the legal frames has been provided. To shortly sum up the regulation hierarchy beginning from the WFD continuing to the application process itself: fixed environmental objectives for water bodies are broken down into measurable quality elements and precise EQS for the water body, which then yield corresponding emission limit values for any discharge to the water body. Whether the stormwater discharge praxis follows all the way down to emission limit values as a condition for the discharge is not sure. Still some conditions, whether it is quality or functional requirements to the discharge, must be set in order to ensure the achievements of environmental objectives. Figure 6 provides a visualisation of the mentioned hierarchy - helpful for the comprehension of the complex relationship between tools of water regulation - as outlined thus far.

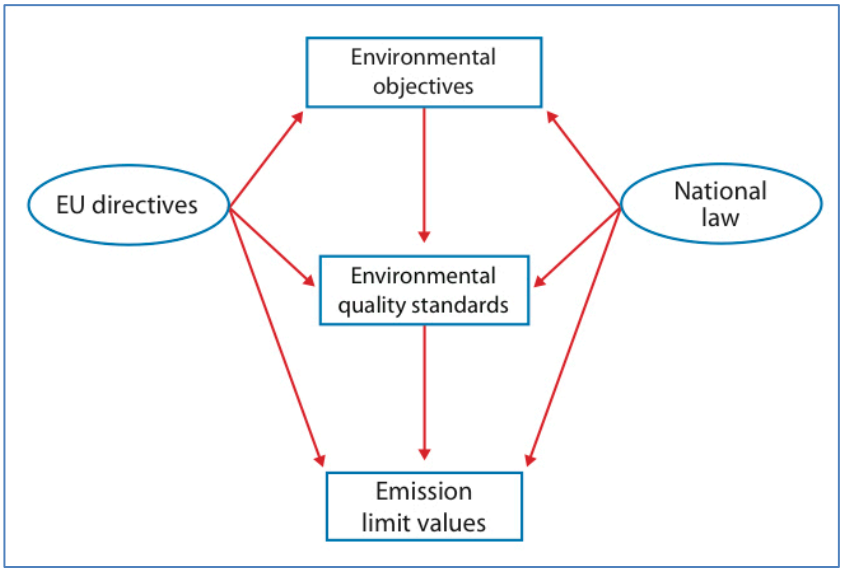

Figure 6. The 'womb' of water regulation. (Baaner, 2013)

3 Method and Theory

The empirical data of this study is derived through an interview study with municipal water managers who process stormwater discharge permits. It means that the findings are embedded in the managers' reflections about their praxis. These reflections are interpreted through a practice theoretical perspective in order to create meaning and elucidate the stated problematics.
The following parts motivate considerations on the epistemological approach for interpretation of empirical knowledge, a presentation of the theoretical analysis frame, a description of the data collection and finally end with an evaluation of the chosen method.

3.1 Epistemological approach

Instead of carrying out a literature study that could somewhat explain the trend of stormwater management, and its implications for reaching environmental objectives, or a questionnaire survey that could give a broader general overview of how water managers work, I chose to look into the water managers' work paradigm through a practice theoretical perspective. I made this choice as I foresaw the first two methods to provide a general picture of the situation today without being able to provide a thorough explanation to the practice besides a description of it. I assessed that a more fruitful and valid method, in relation to the study objectives, was through a qualitative approach, namely semi-structured interviews, where the respective respondents could express subjective views about their work, knowledge and decisions. Expectantly, the method would allow for comprehension of the employee's way of reasoning (Trost & Jeremiassen, 2010). About the qualitative research method Kvale and Brinkmann write that:

"The qualitative research interview seeks to understand the world from the interviewees' point of views, unfold the meaning, which is bound to their experiences, uncover their life world ahead of scientific explanation" (Kvale and Brinkmann 2009:17).

This means, in my approach I started out by seeing reality as the interviewee sees it and hereafter interpreted for meaning and what it implies. In so doing, I chose a *hermeneutic* cognition frame as a way of aiding the conceptualisation of knowledge that I gained through the research interviews. According to the Hermeneutics, valid interpretation can be sought through the meaning of the text, in this case being transcribed interviews representing the spoken word. The spoken word is a narrative about the water managers contextual practice conveyed to me, the interviewer. It is from these narratives that I have interpreted meaningful action on basis of the prior knowledge that I possess. The very prior knowledge that I do hold about environmental science can bias me as an interviewer and researcher, as one might take on a normative approach during interviews and interpretation. At the same time the self-same foresight about the field or background is necessary in that it e.g. enables me to make a respective utterance comprehensible through rules, institutions, or other forms of context (Pahuus, 1995). Thus, the challenge lies in creating balance in the way I choose to use my prior knowledge when I proceed in my research. When a researcher is striving for sensitivity in terms of his bias and subjectivity he is being reflectively objective (Kvale & Brinkmann, 2009). To interpret for

meaning through an individual subjective prior knowledge does not mean that the interpretation is not objective or a reasoned comprehension of the meaningful; rather it means that the gained insight will never be definitive or final. Paahus (1995) describes that it cannot be final because the interpreter is always a part of an "interpretation community" who carry common norms. Yet norms change, and there will at all times be sub-communities who dismiss the perspectives of other sub-communities. In this way, new perspectives repeatedly arise and no one interpretation can thus be more objective than another.

In summary I will in this research context interpret and form meaning from the contextual narratives that the interviewees will provide about their professional work, through the theoretical perspectives to be described in section 3.4.

3.2 Interview study

Four semi-structured interviews including seven respondents were conducted at the respective water managers' workplace, a municipal section for environmental matters, at four different municipalities in Denmark. The interviews took place as group interviews with two water managers from the same municipality participating, as often more than one person take part in processing a permit. One municipality was only represented with one respondent at the interview, as respondent number two was unavoidably detained due to an unforeseen work incident on the day. Each interview lasted between one to two hours.

All the municipalities involved in this study have local water bodies, such as lakes, streams, rivers or coastal waters they discharge urban runoff to. I decided to select municipalities already engaged and somewhat upfront, when it comes to rain storm mitigation and application of SUDS, in order to acquire insight to the problematics and dynamics that they deal with. Therefore, four municipalities, engaged in the *Water in cities* consortium, were selected. Two of these were bigger municipalities and the other two where relatively smaller municipalities. I made this chose in order to create a representation amongst them although I cannot discuss their differences in details because of anonymity, I observed some expressions about economic resources that can differ between smaller and bigger municipalities, and have an influence on their possibility to carry out environmental assessments as part of their praxis.

When requesting the water managers' participation, the context and aim of the study was presented to them all. Two water managers from the same municipality wished to see the interview frame before the interview, thus it was sent to them.

The respondents were told that they were free to deliberate among themselves, if they wished, when answering questions. Trost & Jeremiassen (2010) point to the risk of interviewees supporting each other's view convenient in the situation, during group interviews, causing loss of variation. To minimise this risk, respondents were not forced to answer if they did not express naturally, but space was created so that both participants could engage in the same question. Meaning that, I would make sure to ask both respondents about their view even though one had not expressed very clearly or was being cut-off by the other. Yet, in especially two of the interviews it was perceived as one of the respondents having more to say or stronger opinions, resulting in more speech time for them. In these two cases, the phenomena can partly be explained by the number of years the respective workers had

been engaged in their current work, hence how much experience they could turn into knowledge and narratives. I observed that longer work experience in the field, had created stronger opinions, or more knowledge about the situation, amongst these.
In order to protect the respondents' professional sphere, their name and work place have been anonymised. Quotations in the analysis will be cited as *R1* or *R2,* as in respondent*,* from *Municipalities 1-4*.

Despite a very lengthy procedure, all interviews undertaken were deliberately transcribed personally. This was done in the manner of representing the precise spoken word of the interviewee, to maintain the validity of the transcribed and avoid the risk of losing any nuance for the analysis to come. In total, the transcribed interviews amounted to 80 pages of material for interpretation. The citations included in the analysis to come have been translated from Danish to English. I have attempted to stay as close as possible to the spoken word without exposing the respondents spoken language. Direct translations that can modify the true meaning have been avoided. Yet, the reader will see that the citations have been kept as original as possible.

As part of the thesis process during 2013 I participated in three meetings set out by the *water in cities* consortium. Two of the meetings were organised as 'working meetings' for municipalities, where i.a. the problematic issues and solution possibilities for stormwater discharge management were discussed from several different perspectives. The third *water in cities* meeting was a so-called 'big meeting', where several actors, including representatives from the health sector, municipalities, manufacturers, consultants and others, were gathered to discuss SUDS possibilities and problematics, this time from a planning perspective. A telephone conversation with a consultant from *Orbicon*, an engineering consultancy who are very active in the SUDS field, allowed me to understand some of the challenges they deal with in their work with SUDS, including the challenge of controlling pollutants in the stormwater.
After my data collection, I had the possibility to participate in a meeting organised by *IDA,* the union of engineers in Denmark, on the role of the *stormwater management in the water plan*. Again, several actors such as municipalities, consultancies etc. propounded their issues in working with stormwater management with a respective water plan used as the regulative basis.
By partaking in these meetings I was able to orient myself more about the subject I was trying to uncover and I learned more about the problems that exist in the auspices of stormwater management. Some of the input I gained became a part of my prior knowledge that I could apply in the interview processes and as a form of triangulation. Triangulation is a step in the validation of the qualitative approach

3.3 Interview Frame

The interviews undertaken can be said to have a composite character in terms of the knowledge that was sought. Firstly the interviews were focused on certain themes (see interview guide in table 1) and the goal was to guide the respondent to these themes while refraining pre-assumed views. At the same time some of the questions posed have a specific character with the aim of drawing out specific actions, as these were essential for understanding parts of the interviewees' practice in a straightforward manner. But the overall purpose was likewise to acquire knowledge in a qualitative form, through the spoken word. Kvale & Brinkmann (2009) note that both a factual and a meaning level are sought covered in a qualitative research interview. So saying, a qualitative interview must also be interpreted for meaning after it has been carried out.

Naturally, the bases of the interview questions were the research objectives. Moreover, some of them are rooted in the legal frames that exist for storm water discharge, to receiving waters, as well as the environmental objectives for these. With background in Giddens' 'duality of structure' approach (described in section 3.4), legal frames and fixed objectives become rules and resources that the water managers can apply. How they balance the application of these rules and resources is what is interesting in this context and the reason for inclusion in the interview frame.

The questions about "What is the administrative workers' primary source of information about BAT" (see table 1, column *interview questions*) can to some extent have the character of concept interview questions, but the aim was not quite so. The intention was attaining insight into the respondent's knowledge of BAT and its impact or significance for his or her work. It is possible that the respondent would touch open the concept of BAT already when question number three was posed. However, since the overall interview was not designed as a strict factual interview, there was space for the same subject to be touched open several times. According to Trost & Jeremiassen (2010) this manner of phrasing several questions about the same thing, can be seen as a form of triangulation, eventually leading one closer to the aim. By triangulating, interviewees can verify their own and each other's statements and the connections between the statement (Kvale & Brinkmann, 2009).

Table 1. Interview frame with research questions and interview questions.

Research questions	Interview questions
1. Opening question	• What do you see as the main challenges in your work?

2. How is the consideration for climate adaption balanced against the consideration for the water environment, when granting a concrete permit?	• In which way is it expected that you take climate adaptation into consideration when you process a permit?
	  • Do you experience any problems?
	  • What could it be?
	• Which instruments do you employ, with that I mean: on the basis of which plans do you follow guidelines for climate adaptation?
	• Which political objectives are the most relevant for your work – the environmental- or the climate related?

3. Which terms are set in the individual SUDS/Climate motivated discharge permit on grounds of environmental objectives?	• Which environmental impacts do you consider when processing a permit?
	  • What do you do to ensure the environmental objectives are being lived up to?
	  • Can you mention examples of demands that you do not stipulate but think you could with advantage stipulate in order to safeguard the environmental consideration?
	  • Do you require quality standards for the water that is to be discharged to a receiving water body?

4. What is the worker's primary source of knowledge about BAT?	• What is your understanding of the concept BAT within stormwater management? • Where do you learn about BAT – where do you acquire information?
5. Which rules of law do the administrative worker emphasise – those that explicitly abide by discharge permits – or those that explicitly abide by the management in accordance to environmental objectives?	• Can you tell, which rules of law that lays the basis for your assessment of an application? • What do you think about the water plan – is it helpful for your work?

6. What are the administrative workers' primary source of information about the rules of law and the combined approach of article 10 of the WFD?	• Are you familiar with the combined approach from the WFD's article 10?
	  • What do you understand by it?
	  • Is it relevant for your case handling?
	  • Does national law make possible the requirement of BAT in permits?

7. Closing question	• What could ease your case handling Or • Do you feel you are in need of clearer guidelines?

3.4 Theoretical perspective

Data, be it qualitative or quantitative, will never be noteworthy on its own. It is only when processing and analysis is undertaken, that data become useful and can bring about understanding of a situation. In line with this, Trost & Jeremiassen write:

"Another difference between our interviews and the journalistic ones is that, we are never interested in letting our data "speak for itself"; our data are not interesting, before having been interpreted through a theoretical perspective" (Trost & Jeremiassen 2010:46).

In the below the theoretical perspective chosen to illuminate the finding to come is described.

3.4.1 Giddens' Theory of Structuration

Following Trost and Jeremiassen's rationale, I have chosen to draw on Anthony Giddens' Theory of Structuration or "approach" as a theoretical frame, in order to comprehend the practice of the water managers. I look into the practice of professionals who are already operating within certain structures, in this case an environmental section within a respective municipality. For this I employ Giddens' notion of 'duality of structure', where he propounds that action and structure are a mutually constitutive duality, meaning two aspects of the same thing. He goes on to state that practices are a part of 'duality of structure' in that they consist of both structure and action (see figure 7). Giddens conceptualises structure as:

"[…] rules and resources that actors drawn upon as they produce and reproduce society".
(Layder, 1994:138)

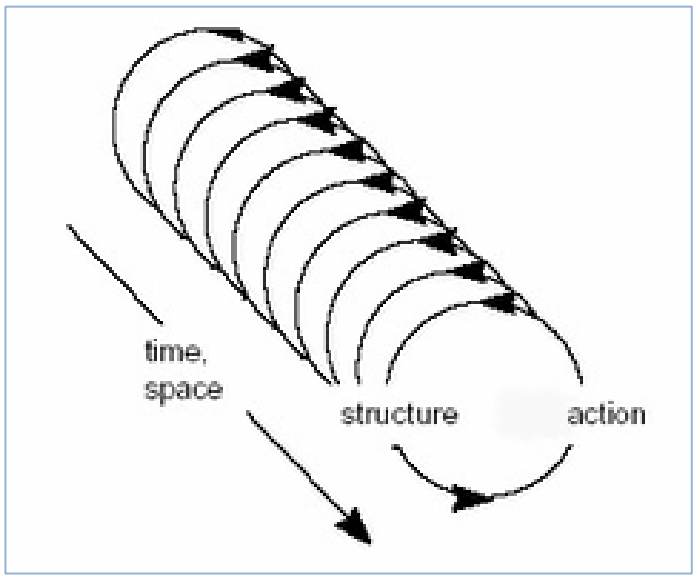

Figure 7. Illustration of 'duality of structure' reproduced trough time and space (Rose & Scheepers ,2001).

As part of Giddens' concept of 'duality of structure' several notions exist, of which one is the *agent* with a practical consciousness that underpins his/her day-to-day habits. The agent moreover has a discursive consciousness, and as such is a reflexive being, reflecting on its own behaviour and conditions thereby having a choice in the matter, in another word, having power to make a difference (Layder, 1994). Giddens himself puts it as:

"To be able to act 'otherwise' means being able to intervene in the world, or to refrain from such intervention, with the effect of influencing a specific process or state of affairs." (Giddens, 1984:14)

In his interpretation of Giddens' approach, Layder (1994) writes that deep down people are engaged with society and actively enter into its structure. People create, support and change it, as it is the nature of human beings to be affected by and to affect their social environment. Said differently: people's reflexive behaviour, motivation and reasons are crucial factors for the existence of social structures, institutions, and systems. This notion can be applied to regard municipal water managers, in this context, as agents who can influence the structures within which they operate and likewise sustain these. Following Giddens' approach, a municipality is perceived as an administrative structure founded on rules and resources that its employees, the agents, both bring and draw on in their recursive actions, resulting in creation and re-creation of both structure and actions. This way, the municipality as structure is not external to its employees; the municipality as rules and values is both a mean to and a result of their practice. For a detailed description of concepts in Theory of Structuration see appendix 3.
It is important to mention that in this approach, the notion of structure consisting of rules and resources can be enabling, but also constraining, in that the agent is not always in possession of an applicable rule, e.g. a useful language in a specific context (Kaspersen, 2001).

3.4.2 Characteristics of modernity

Besides the notion of 'duality of structure', Giddens propounds a perspective on the late modern society and what it implies for human action. As a constituting part of his perspectives on modernity, Giddens draws on what he calls 'dynamic characteristics of social life'. These features will be presented here as another integrated element in the attempt of understanding the praxis of the water managers. Albeit not all features will be applied in the following, they will all be described, as together they provide a better understanding of Giddens' grasp on modernity.

The first feature of the modern society is the *separation of time and space*. The separation of time and space is the requirements for the articulation of social relations across large time-space distances up to, and including global system (Giddens, 1996). As an example, we need not be in the same room, nor in the same country, when we communicate with each other; the connection can be sustained though the telephone or the Internet. Next is the concept of *disembedding mechanisms*, the first one being symbolic signs such as money, power and language. The second: *Expert systems,* systems of technical or professional expertise, organising great parts of the material and social environments we live in

today. Together, the disembedding mechanisms are referred to as *abstracts systems,* and they remove social relations from the immediate closeness - in the context. The retention of the abstract systems is dependent on *trust*. As an example we must believe in the agreed value that money has in order to make use of it, as well as trusting the expert systems when our own knowledge on a certain matter is limited. Giddens (1990) exemplifies it as simple as: trusting that the foundation of one's house is made in a sustainable manner by the construction experts, is trusting the authenticity of the expert knowledge applied in the construction; knowledge we most often are not able to scrutinise in details. As such, our whole society is built on expert knowledge. Each interaction with, or use of, the given materials and resources in the society requires trust in the system and an acceptance of possible risks. At the same time trusting that the risk of hazard truly are minimised by the experts - e.g. when we go for a drive in our car on the highway (ibid). Giddens write that a condition for trust is not the absence of power; rather it is the absence of full information - a perspective I will return to in the following analysis.

Now, not being knowledgeable about everything does not mean that all is accepted and trusted just like that. Agents of the modern society are aware that the abstract systems have their limitations. As such they constantly examine and reform social praxes in the light of the inflow of new information about the self-same praxes, resulting in a fundamental change of their character (Giddens, 1990). This constant scrutiny and third immanent feature of modernity, Giddens calls *reflexivity*. Through their reflexivity (knowledge) agents can actively sort through the competing action possibilities, which the modern society offers. Giddens' notion of reflexivity is also referred to as *institutional reflexivity*, carrying the same meaning (Giddens, 1996).

3.5 Interplay between theory and results

Applying Giddens' approach on structuration, and as well his perspectives on the modern society, made it possible to reveal some clear patterns in the praxis of stormwater discharge assessment. Giddens operates with clearly defined concepts as laid out above, making his theories easy to use as an interpretation frame. Also it seemed reasonable to utilise Giddens' Theory of Structuration, and perspectives on modernity, to illuminate the findings, instead of a more structure over action approach. As an example, the approach of a functionalist as Durkheim, in which individuals' behaviour is often constrained and reduced to a product of top down forces (Giddens, 1984). The reasoning is firstly, as my attempt was to understand the practice of a group of professionals, in a contextual sense, it made sense to acknowledge their ability to be purposive and reflexive beings, who through their reflections and engagement with their social systems form their practice. Secondly, the aim was also to understand the constraining factors that influence the professionals' position and more importantly *how* these constrains influences their practice. These aspects were part of the professionals' discursive consciousness during the interview. About the discursive expressions, Giddens states:

"Actors are also ordinarily able discursively to describe what they do and their reasons for doing it. […] The rationalization of conduct becomes the discursive offering of reasons only if individuals are asked by others why they acted as they did. Such questions are normally posed, of course, only if the activity concerned is in some way puzzling […]" (Giddens, 1984:281).

Now, while the professionals' action of managing stormwater was not deemed puzzling or odd per se, it is the circumstances, the existing or non-existing guidelines, on which the practice is founded, and the consequences it has, that can seem puzzling. But as explained earlier, this is the structure that the actors draw on in their recursive actions, meaning they re-create structures. Thus, by looking at both practice and rules at the same time, a clearer picture revealed. This is why the point of departure was the water managers who process permits and it is why it was they who were asked why they do as they do. As will be further clarified in the analysis chapter, the agents of this study, the water managers, are constrained by rules that are lacking in their practice, yet, they are also reflexive enough to work around the limitations and attempt to, to the extent it is possible, create the rules that are lacking in order to advance their practice. The interplay between theory and results proved to be sound as a proper understanding of the municipal stormwater practice was gained.

3.6 Validity, reliability and generalisability

I discovered that the water managers foresee problematics in terms of climate adaption balanced against the consideration for the water environment. However, there was a future dimension to their narratives about this problematic and not all municipalities have yet pieced together their climate adaptation plans. Thus, a clear idea, of how climate adaption is balanced with compliance of environmental objectives, was not gained from the interview study. I do not dismiss the results of research question 1 (see table 1), as they still bring valuable insight to a rising problematic. Rather I will argue that the *validity* of the question and answers on this matter will probably be higher if the same problematic is investigated in two or three years. By then, all municipalities will have enacted their climate adaption plans as well as water action plans. Hence, a more fruitful understanding can likely be attained in the near future. As a consequence of the above discussion on validity, results about the climate change problematic will be included in the analysis chapter, to allow the reader insight to the findings, but will not become a part of the discussion.

Furthermore research question 5 of the interview frame (see table 1), was not answered in an either/or manner. This is firstly because it is a question that calls for a normative answer, as the water managers with their position optimally must state that they emphasise rules that explicitly abide by the management in accordance to environmental objectives. Thus posing research question 5 directly would not have derived useful results; therefore it was posed as a question seeking to uncover a fact. Even though the facts uncovered did not answer the research question, all the questions in the interview frame together - in a triangulative manner - worked to bring out the dynamics of the praxis, which cannot be said to be one-sided. This means that the results of this study show the praxis to be more varied than what question five assumes it to be.

In general, the interviews contributed with thorough insight to a praxis and the challenges that the water managers face in their work. The qualitative data, the narratives of the respondents, underpinned each other in a quantitative manner and thus proved their validity, and the suitability of the chosen method.

In line with the hermeneutic realm, the *reliability* of this qualitative study is dependent on the prior knowledge that the interviewer possesses. Another interviewer with a differing knowledge background can, because of the very background difference, bring out different statements about the same subject, depending on his sensitivity to and knowledge about the interview subject at hand (Kvale & Brinkmann, 2009). Thus in that case, the outcome of the study could differ to some extent.

The *generalisability* of the findings is supported by the local context that this exploratory study has as point of departure. As Denmark has still not enacted its water plans, it has as such not commenced the achievements of environmental objectives as set out by the WFD. Thus, all municipalities are still waiting for an enactment of the final versions of their regional water plans to be able to adopt their municipal water action plans. This means that other municipalities, than the four in this study, are most likely dealing with the same issues, such as unclear environmental objectives and a vague knowledge about water body status, which can influence their praxis.
Because aquatic environmental data is no longer collected on a regional level, and the NOVANA programme is now governmental, it has created a lack of sufficient data. This is an impediment that came forth in this study, and is a generalisable impediment for environmental assessments carried out in all municipalities of Denmark.

4 Analysis

In this chapter I analyse the derived data, which are in the form of narratives. I look into the characteristic of the findings and seek to comprehend these in the light of the chosen theory. Divided in several themes in connection to the interview frame and what emerged from the empirical data, essential meaning from the revealed patterns is drawn. It means that I analyse the practice connected to the notions of the theory – with an overall focus on enabling and constraining factors influencing it. As discovered through the empirical data, the field of stormwater management seems to be influenced by some structural constraints, which will be elucidated here. Nevertheless the constraints to be drawn out can, as Giddens would put it, show itself to:

"[…] operate through the active involvement of the agents concerned, not as some force of which they are passive recipients". (Giddens, 1984:289)

The emerging themes were as follows:

- **Current practice**
- **Compliance with regulation**
- **Technology in practice**

These themes are in the below divided into two sub themes each.
In the extracts to come () means a word is missing as it could not be heard during transcriptions and (()) containing a word provides my own interpretation of the implicit meaning of the unspoken. […] means that a previous sentence has been left out, without distorting the meaning of the following. Moreover, longer extracts will figure as they are often descriptive and pulling quotes out of context could misrepresent the meaning.

4.1 Current Practice

In this section issues like challenges in the water managers' work, and an analysis of their respond to the challenges, according to the told narratives, will be uncovered.

4.1.1 Learning while doing

When four water managers from two different municipalities were asked about what they perceive as challenges in their work, two similar issues i.a. emerged. One of these was about the lack of experience and knowledge that exist in their field:

We are trying to collect primarily Danish and Nordic results to gain an idea about, can one say: 'if it's from this type then it's not problematic, if it's from this type of road then some kind of treatment is needed'. […] You could say this is something the Nature Agency should take a stand to. It could be nice if they say "if it's this type of road, you should have this kind of facility", but they don't do that…it's somehow a bit of an assessment. (R1, Municipality 3)

And in line with the above:

…so from an administrative point of view it's about making it as simple as possible for the applicant, but also for the ones who process the case. So it would be nice if one could boil it down to saying "well it's only the roofs with copper e.g. that's a problem and the others are less problematic and here we can stipulate simpler terms to how it's discharged. It's somehow what we are trying to work towards […] to a point where it's not too heavy to work with. But meanwhile, it's pretty hard because there is not so much experience so we are often in doubt…and there are not many to ask ((for guidance)). R2: No, we are in reality in doubt about the water quality (). (R1&R2, Municipality 1)

Lack of representative and guiding data on pollution composition in stormwater, in terms of what kind of surface it has been in connection with, has resulted in all the professionals engaging in practices where they can acquire the lacking knowledge. They engage in fora with other professionals in the same position from different municipalities. They meet in these fora once in a while and share and acquire new knowledge on the area. Or they engage in projects, which can include academic institutions, consultative- and utility companies to hear about and try out new treatment technologies. Furthermore, the need of knowing what the pollution-level already is in the receiving waterways, i.e. its status, also emerges in the interviews. Once again, activities where data can be acquired by specifically carrying out measurements in designated waterways are mentioned. Nevertheless, the problem of sufficient funds is also mentioned as a barrier for the environmental monitoring.

Looking at the phenomena arisen as result of the insufficient knowledge mentioned by the professionals, we see that social systems, fora for knowledge sharing, with the professionals' activities embedded in a specific context, i.e. stormwater discharge, is created.
Social systems are relations between actors organised as regular social 'practices' (Kaspersen, 2001). By engaging, they share rules and resources lacking from another structure they also are part of sustaining. In this way, they attempt to transfer rules and resources from these social systems, the fora, to another structure, the municipalities. In other words these actions are capacity building activities resulting from a knowledge gap that the professionals are seeking to re-forge.

4.1.2 Climate adaptation – how big an influence?

Going over the issue of climate adaptation with the water managers, and which influence it has on their praxis, it became clear that climate adaptation is more or less a part of their praxis, although to different degrees, depending on the geographical and topological localisation of the municipality. All the water managers were aware that climate adaptation was being integrated into the municipal plans. Nevertheless, detailed climate action plans are only being worked on and have not fully become a part of the their administrative praxis. Therefore, a time dimension, *the future,* often influences the reflections of the water mangers:

Well, at the moment there isn't that much, but there is a lot in the pipeline (figurative) in terms of climate adaptation, right now it's more regular permits. […] But there has been made a few...last year there were some cloudburst solutions out to the harbour to show that they did something. So they, roughly speaking, made some wholes out to the harbour a couple of places, where they were allowed to discharge some water of a 10-year rain event. Those were the first real cloudburst solutions we have processed. But there will be a good deal, there will be more relatively simple discharges to the harbour soon I think. But then it will be coming over the next 20 years, big and small projects in between each other, it can be anything from this little street needs a discharge to the harbour here, to a big tunnel, to parks that will be re-organised. (R2, Municipality 1)

They also reflect on how the conflict of interest that they foresee and to some degree already experience:

I think, or we think, our assignment with the job function we have, it's to manage the water environment….but it's of course not our role to block the climate adaptation, we must of course be a team-player to it, but it's a cross field sometimes, where you can feel a bit tangled up maybe. And it hasn't been that bad yet, but I can see it coming, unless you become more clear on what you can do and what you can't. (R2, Municipality 1).

One of the water managers further explains the possible conflicting situation, when I ask whether he feels there is pressure for climate adaptation while they at the same time have to achieve some environmental objectives:

Yes, you could say that. Well our utility company need to live up to that function ((climate adaptation)) in praxis, so they might say "if we are to do it, we need to do separate sewerage system in this area, if it's not to flow over terrain more than those x number of years" every 5th year or 10th year or whatever it is in the different areas […] and that can be in conflict with the Environmental Objectives Act…We can't allow that you discharge more water here e.g. Either there isn't the hydraulic capacity for it, or it ((a receiving water body)) can't handle more impact here. So there can easily be a conflict between those things. There is also at times a conflict with what the utility company want in their ideal world and what the receiving waters actually can handle. (R1, Municipality 4)

One of the water managers point out that they had pieced together their own guidelines on characteristic water flow in their catchment, which turned out to be much lower than the widely used rule of thumb for water flow to be discharged to receiving water:

But that's why we have to make those guidelines, because we can't keep saying yes to discharges, because at some point it's not negligible any longer, because there is so much water it's not possible even though it's 0,2 L/s/hectare. (R1, Municipality 2)

The above statement shows that the discharge flow guideline stated in the water plans (1-2 l/s/hectare, described in section 2.3) are not applicable, when the real flow of the municipal streams is much lower. The statement indicates discrepancy between guidelines and the real natural situation.
As described earlier, a receiving water body can become hydraulically stressed if its natural water flow falls much out of balance, thereby impacting the ecology of the water body as well:

We can state that the increasing urbanisation and climate changes have resulted in nearly all our streams having, what I would in scientific terms, call hydraulic stress. Meaning that with a rain event they rise drastically, racing away, and when the rain event is over then - plop - falling back down. Then we'll simply have a brink where there is no vegetation because it too often is flooded, and at the same time there is no bed vegetation because it's too often dry, meaning there is just nothing. And such a stream without anything in for maybe half a meter or three quarters of a meter, is incredibly vulnerable when there is such a flush, then we'll have an immense erosion in the streams and the material deposits in spawning banks and on habitats […] I mean it's a really vicious circle. […] Our streams are often 100-120 % stressed because of these stormwater discharges. And it's bad, and we'll never fulfil the water plans for such a stream, because if we destroy the habitats for some of the species needed to bring it ((the stream status)) up to a DVFI 5 […]. (R2, Municipality 2)

Continuous hydraulic stress from stormwater discharge can impede environmental objectives and therefore this municipality has been obliged to make their own flow guidelines they can use as an argumentation tool in negotiations with the utility company. A smaller flow in the streams requires bigger delay wet ponds, which will turn out much more costly for the utility company as well as demanding the available space for the placement of them. The issue of higher cost for the utility company is the reason why the municipality is in need of a strong argumentation in their attempt to prioritise the water environment and live up to environmental objectives.

One of the water managers points out a measure from the water plan, which he sees as problematic for the climate adaptation:

In the water plan it says that we have 20 km of stream that we shall no longer maintain, meaning not removing weed in the streams twice a year. We remove the weed to allow for the water to flow away, it's not because of the stream environment, on the contrary, it's not that good for the ((water)) environment ((to remove weed)). We do it because of the legalised stream discharge possibility. We have 20 km we are not to remove weed in any longer, it harmonises really bad with the big challenges in terms of climate change and stormwater discharge that we have. (R2, Municipality 2)

As the water manager describes it, increasing water quantities for streams with lower flow ability is an impediment for the foreseen need of climate adaptation.
A general awareness of the challenges that will arise, and already have arisen, as result of climate changes is present amongst the water managers. Through their reflections it became clear that they know that there is a need for an update in the work structure in order to balance the climate adaptation with the consideration for the water environment. On one hand there are the planning and service oriented actors (e.g. utility companies) focused on handling the increasing amounts of storm water and on the other hand the water managers who need to integrate the sake of the water bodies, at all times, in the stormwater management. So once again, knowledge on the state of the water environment and how the climate motivated praxis can be carried out sustainably, becomes an important element in the development phase that stormwater discharge will go through as a result of climate adaptation.

4.2 Compliance with regulation

In this section I integrate the regulative aspects that underpins the professionals' practice as it is connected to research question one (see page 3 above). I do this to see if there is any discrepancy between what the law stipulates and what is actually done by the practitioners. The aim is to understand the reasons for discrepancy and also how the water mangers balance environmental objectives with other municipal goals of e.g. stormwater management set out in wastewater plans. I asked the water managers, which rules of law they applied in their work. The answer was broad. Meaning that they would apply anything from the regional plans, the water plans, to wastewater plans, to any of the nature protection laws etc., depending on the physical context of the discharge applied for. It became clear that the water managers operate with any applicable law relevant for the actual application. As such, no distinct patterns were revealed, meaning that it did not become clear whether the weight, in their practice, was put on the environmental objectives set out for water bodies or on the actual need of stormwater discharge. This was in connection to the 5th research questions of the interview frame. Meanwhile, a regulative tool that in the future will underpin the stormwater practice to a higher degree came out as a challenging element and is elucidated in the below.

4.2.1 How can we use the water plans

The municipalities are responsible for putting the water plans into practice in the near future, and although the government has not yet enacted the draft texts, they have been available for some time. I was interested in the interplay that the water plans can have for discharge permits, thus I looked into whether the professionals had already taken a stand in terms of the plans and the plans' influence on their work. It is relevant to study this, as in the future the guidelines and measures given in the water plans will be integrated into municipal water-action plans and thereby become both the foundation for administration and means for achievement of environmental goals.

The reflections of the respondents shed a light on how manageable the water plans, as an administration tool, actually are:

Well if you look into that act ((Act 1022[12])) it's not applicable to stormwater discharge and that irritates me sometimes, so I think that……In the water plan there hasn't been dealt very much with xenobiotic compounds….I would say…so it's a bit hard to…. e.g. we have some discharges we would like to do something about e.g. from highways and such, but if the receiving water body lives up to its objective, then it's a bit hard for us to come and say: "You should do something about it", because if you can't compare () with the environmental quality standards….you could then say, that the stream is living up to its objective, but maybe it could do even better right! Here, we sometimes need some tools I think…I have a concrete discharge I would like to deal with but we don't really have anything ((referring to regulative tools/measures)). But you can see that there are all kinds of suspended solids coming out.
(R1, Municipality 1)

I see the situation of the water manager as one where he wishes to act in terms of a discharge that is polluting, but is not able to because the water body in question is living up to its environmental objective - according to his indication. Yet, the water manager had wished he had more stringent thresholds to operate with, and expresses irritation over Statutory Order 1022/2010 that does not cover stormwater as he reads it, thus he cannot employ its provisions for stormwater. The fulfilled environmental objective reveals itself as an "acceptable level of pollution" and in this case it seems impossible to ameliorate the stream condition, because there is no further regulation despite visible pollution.

Four other professionals express similar patterns of constrain in terms of the water plans' lacking regulation- and data on xenobiotic compounds and other pollutants in both runoff and the receiving waters:

But I don't think you can use the water plan as a guide for some of those xenobiotic compounds, which we are dealing with concretely. It's 1022, which is still the detailed. (R1, Municipality 1)

[12] Statutory Order (1022/2010) on environmental quality standards for water bodies and conditions for discharge of polluting compounds to stream, lakes and the coast. See section 2.4 for further explanation.

The area specific water plan itself, according to the below statement, does not stipulate measures for stormwater discharges. One of the respondents reasons this by pointing out how stormwater has still not been acknowledged as a pressing issue:

R2: Well, if you talk about stormwater discharge, then it's not of help, because there is no regulation at all in the water plan as we have read it. There is only regulation of combined sewer discharge, here we can apply it, but on stormwater we can't use it, there are no announcements.
R1: Not besides that you shall not hinder good ecological quality.
R2: […] but it's probably pretty new, that you've found out that rainwater isn't as clean as you thought, or actually you've known that for some time, but you've just not really. You haven't done anything about it, and the water plan [….] doesn't set any terms for it. And you regulate it after 921[13]*….and we have more and more in terms of salt and pH and those compounds are a problem, but we have no regulation possibilities, or at least it's hard to find and the water plan gives us no possibility.*
R1: No, not directly. (R1&R2 Municipality 3)

Once again, the problematic of not knowing how much pollution a water body already contains, which results in not being able to properly regulate the discharge comes forth:

I think in terms of the compounds it's very complicated, I mean it's hard to relate to…I mean, what can I use it for when I'm sitting and processing a permit. Because they've said, there can be this much in the stream, but when we don't know the background…then I can't know how much I can load. And we simply can't screen all our streams everywhere to know the background compound content for all of them….so it's a bit like yeah….your experience, like what do you think of this compound, which is usually heavy metals, oil if it's road runoff and these things. (R1, Municipality 2)

Despite the water manager's discursive reflection on lacking data on stream pollution and how he is constrained to rely on his own assessment for his work, he must carry on his practice. As such this water manager is making a pragmatic accept of the unknown, when he chooses to carry on with his assignments and assessment based on non-optimal knowledge. Pragmatic accept is what Giddens (1990) calls an adjustment reaction to modernity's risk profile, but it cannot be a continued reaction because the expert knowledge which flows our way is always fragmented and inconsistent. I assume Giddens means that to some extent agents will focus on 'getting the job done' (being pragmatic), but as they, at the same time, are reflexive beings influenced by new knowledge, flowing into society, they will revise their practice continuously. Yet as long as the water manager is acting 'pragmatically', his recursive actions will, according to Giddens (1984), have unintended consequences. By unintended consequences I do not mean pollution of streams (I will leave out this more scientific judgment here) rather the consequence is that he is maintaining the practice of assessments based on personal judgement, based on one's prior knowledge, rather than on updated guidelines.

[13] Danish Statutory Order 921/1996 on environmental quality standards for water bodies and conditions for discharge of polluting compounds to stream, lakes, and the coast. This Order is cancelled and instead Statutory Order 1022/25/08/2010 is in function. The water manager is thus referring to an outdated Order.

When the water managers talk about the water plans they especially they reflect on the use-value it has for the pollutant profile of stormwater, which they find problematic. They are aware that it is a problematic area needing attention, yet they stand without proper rules in form of information, guidelines and data they can apply in their practice. It appears they were expecting this area to be integrated and illuminated by the water plans.
Another interesting thing is the reference to Statutory Order 1022/2010 (one water managers refers to an outdated version), which formally leaves out stormwater in its regulation of discharge of polluting compounds. One respondent elucidates how it becomes a matter of personal judgment, based on what he knows about concrete pollutants, when processing a permit. According to the description given in section 2.4, the water managers must live up to the EQS given in Statutory Order 1022/2010 when they assess their permits, But it is not clear whether they apply this statutory order or not. However one thing, which becomes clear is the lack of data on background pollution concentration in the streams. If these data are not available to them it makes it more difficult to know how much more 'pollution' the receiving water can take, as one respondents puts it, thus also more difficult to assess the EQS for a water body.

The water plans' concept of 'environmental objective' and 'good ecological status' is brought into play by some of the water managers and for some it seems to be the possibility for stronger regulation. One particular view depicts this distinctively:

Well, I think it's fine, if we don't, if I don't meet any inquisitorial questioner, then I think it's fine to say: "well we have a condition in the water plan for living up to good ecological stream status and that's a DVFI 5. Then the water plan is really good, because then I can just say WATER PLAN! […] and we know how DVFI is in our streams, we have exceptionally together with the utility company made lots and lots and lots of monitoring stations, because that's what's cool about the government, it's that all those NOVANA stations we had in the olden days; they've been ditched, there are three of those left in our municipality where you assess DVFI…that means the data that there is in the water plan, which R1 is using, they are outdated". (R2, Municipality 2)

The water manager is obviously relieved that the environmental objectives of the water plans are strictly binding if a stream is assigned a fixed objective. Seen through the lens of the Structuration Theory, the water manager is applying both a codified rule - the water plan - and his authoritative resource, which is his status as municipal employee, to conduct his praxis. But according to his own narrative, it is the existence of the water plan, the rule, which will ease his practice. Yet, rules and resources as such go together, and he becomes empowered in that he is able to effect change both through his status but also by an applicable 'rule' (the water plan). Moreover, the practitioner expresses irony about the decision that governmental institutions have taken on cutting down the monitoring of streams, which results in his colleague basing her work on outdated data.
Nevertheless, their situation becomes improved when the local utility company (paying for the monitoring survey) includes the municipality in collaboration of an extended monitoring and data collection in local streams. However, it seems not to be the regular practice that utility companies pay for monitoring of streams, as this task is governmental. In this case, I assume the utility company has

done it in their own interest to be able to carry on with stormwater management, and for this information on stream status is needed. The utility company has the necessary financial resources they can allocate and as such they are empowered to provide the lacking element (knowledge on stream status) needed in their agenda, which is stormwater management. Further below, another water manager recounts on how applicants carry out surveys in order to provide the data needed for the assessment. As such it seems not unusual that the applicant will do his part to accelerate the assessment process.

Another water manager correspondingly points to the problematics about the NOVANA program, which is set out to provide environmental data, on water bodies:

We don't know e.g. what the content of xenobiotic compounds is in some of the streams. We are not allowed to permit a discharge unless […] we must ensure that the environmental quality objectives are still lived up too. That's a bit hard when you don't have any background information and actually don't know what the background concentration is. We have been obliged to do measurements in this lake and measure for a range of metals because we had to make a new discharge permit, but this was supposed to be a part of the NOVANA program, but it's not. […] It's been cut down to nothing this monitoring program. We do it sometimes, but only if it's strictly necessary or sometimes we also do DVFI measurements in the streams. (R1, Municipality 4)

At a third municipality they, in unison, confirm the reductions made in the NOVANA program. Additionally, they underline the responsibility of the Danish Nature Agency to provide environmental data, but understand that political prioritisation can influence the data provision and use of funding. They are also aware that the very lack of knowledge has led the Nature Agency to make changes in the coming water plan:

R1: But sometimes we have to…we do some assessments from the available knowledge we have, which maybe is minimal at times. We have also been out taking some samples from the coast, to know the background concentration of heavy metals e.g. and we don't have anything else than that. It's better than nothing.
R2: It makes it difficult, because in reality it's not the task of municipalities, but the Nature Agency doesn't…provide what we need.
R1: And then it becomes a bit sporadic, when sometimes there is a specific case, the applicant would also do some surveys because they are interested in ().
R2: But it feels like it has become very riddled this monitoring program.
R1: Yes, NOVANA, It's very - how to put it - random sampling, what is taken out, of xenobiotic compounds at least…e.g one sample in Oresund once a year, maybe here and there and it's like there is something missing ().
R2: So it feels very much like…- with that we are dealing, we need some time series…to see if it has become worse or better.
Interviewer: Where do you find that then?

R2: Well, that's the thing, now they might be riddled, so it's maybe every fifth year they ((the NOVANA program)) has been out to check, and what's happened in the mean time??
Interviewer: So it's still the data ((NOVANA data)) you are using?
R2: Yes, because we don't have anything else.
R1: And then again, in our municipality we have during the years done some different surveys. But it can seem a bit random what we have, by chance, surveyed. It's riddled. (R1&R2, Municipality 1)

The NOVANA program is mentioned by several of the respondents as a monitoring program that has been very much cut back and has become an insufficient guideline, after the government took over the program from the former counties. Nevertheless the need of time series to make a proper assessment is evident when the aim is to live up to environmental objectives.

Several more statements on the water plans further reveal the water plans' weak data-basis:

As GIS material, it's ok, because there you see what the status is, and what the objectives is, approximately what the colour impact they have. But as I said, the thing with the guiding 'natural flow' – that, we can't use for anything, when we have measured ten times lower than that. We can't keep saying that the flow ((of streams)) is 1-2 L/s/h when it's only 0,1, so we can't use that. (R1, Municipality 2)

As well as differing perceptions:

Well a part of the down side about the water plans is that you allow yourself to condition a municipality by saying: "Go to our homepage, on our map ((WebGIS)), and see if you can find your terms" really, I think it's indecent. (R2, Municipality 3)

I ask yet another water manager what he thinks of the water plan as data basis:

Well its old news really…it is. But if you ask The Nature Agency it is the incarnate truth. That's where we have the diverging perception on how good this material is. And surely, we must take what is written in the water plans as point of departure. But we don't work against our better judgment, if we know something else, then we use that. (R2, Municipality 2)

Despite the existence of the water plans, continuation of a lower denominator seems to be ruling the regulation of stormwater discharge according to the statements of the professionals. One rule the practitioners will in particular draw from the water plans is the DVFI, the environmental objective fixed for a water body. Even that can seem insufficient for reaching environmental objectives according to what the practitioners express about lacking data on the stormwater pollution profile, as well as the state of the receiving waters. As such, it becomes a matter of personal judgment and even though the practitioners are there to provide but a qualified assessment, their statements emphasise that proper support, in form of data and guidelines, is needed.
By allowing the practitioners to reflect on the water plan and its use-value, an understanding of the water plans and its future impact on their practice was gained. In this way, light was shed on areas

that need attention and which could be either included in the coming municipal action plans or in the water plans of the next water planning cycle. It became clear that in terms of guidelines on how to deal with stormwater discharges the water plans are not significant. The specific guidelines on stormwater management - outlined in section 2.3 – are limited and in terms of stormwater technology refer to guidelines that are more than 20 years old. In subsection 4.1.2 one municipality points out the discrepancy between flow guidelines that the water plans provide and what they have actually measured, which is much lower than the guideline. In conclusion it can be stated that the importance of the water plans, for stormwater management, is the fixed environmental objectives as well as information about current status that it can provide.

4.2.2 Functional or quality requirements?

I wished to understand the rationale basis for how the water managers assess which kinds of terms and conditions to stipulate in a discharge permit in connection to research question two (see page 3). In attempting to do so, I asked one of the municipalities whether they consider the concrete receiving water body and its environmental objectives, and here is what they answered:

R1: You always do that! It's always very concrete. Depending on which kind of discharge we are doing, we have some standard requirements, which is a list, that doesn't mean we stipulate all the requirements each time. It means we say "ok, first of all is it freshwater or marine water?" And then we look at the individual and say "is there something special we need to assess as well? And then "these parameters are not relevant here e.g." or something need to be added e.g. if it is polluted soil or something, so there can be some extra compounds that demands analysis. So in that sense, it is the concrete place where the discharge takes place. It can also be the harbour, some circumstances about bathing water, bathing water quality in the summer, and actually you can swim there the whole year around. So, there are some things you need to be sure doesn't deteriorate the bathing water quality, so that we are obliged to close all the harbour baths e.g.
R1: It has high political attention. (R1&R2 Municipality 1)

When I asked the water managers more concretely what kind of requirements to the stormwater they stipulate, they concurrently point out the same dilemma about quality requirements vs. functional requirements:

We have this problematic, that it is really hard to take a sample […] because you need to sample when it's raining and when it's overflowing, because otherwise the unclean water has drained with the first flush…and hitting just when the first flush is draining to the stream; there is simply no one who can do that. […] If it's an on-going drainage, if it's always like that, then we can say "ok, we need to change the functional requirements or we need arrangement requirements on those lots or what else it should be". But if it's because it hasn't rained in two months and the parking lot is really dirty...three weeks after we have the analysis report, yeah… (R1, Municipality 2)

Another view on the sense it makes to require analysis of the stormwater:

The problem is that it varies a lot, what enters the surface water, when you measure, it's very different whether it has been raining for a long time or not, whether it's a heavy shower or not. […] also when you are talking about other types of permits for wastewater, it's better to stipulate a requirement for a good treatment technology rather than stipulating a condition for a whole lot of samples afterwards; because the samples are snapshots. (R1, Municipality 3)

The water managers' assent on the dilemma of water quality requirements or functional requirements in permits, depicts the challenges they perceive to be associated with quality requirements. Unless they have an interest in monitoring a certain facility and drainage then stipulating quality measurements is the exception, hence it seem to be the functional requirement which is the rule and procedure at the moment.

The professionals evaluate time, economical proportionality, accessibility, practicality and status of the receiving water, as constraining factors when they consider whether to stipulate quality requirements or not. They also look into the materials, which the water has been in contact with and on what type of drainage area the water flows. There seems to be much awareness about copper, a heavy metal. One of the water managers mentions how they also attempt to avert the use of specific building materials, such as zinc and copper, in the municipality. For this, they have integrated a restriction in their district plans.

Question six from the interview frame (see table 1) concerning article 10 of the WFD and BAT was part of a triangulation on trying to understand how the water managers reason whether to stipulate requirements for BAT or emission limit values in regard to EQS. As they were not questioned directly it was not clarified how much weight the water managers put on Order 1022/2010 and if they followed its provisions or not. A reason for this can be the very-same ambiguity that this order causes, when it formally does not consider stormwater discharge. Hence, there were mixed messages on whether it was considered or not, as well as how it was considered. Nevertheless, the trend on whether the water managers emphasised stormwater quality requirements or functional requirements did became clear. I discovered that the WFD itself is not necessarily a regulative tool, in which the water managers look during their practice. Mainly Danish regulation is what they draw on, and this was expected as EU regulation is implemented into national law. When talking with the water managers about the provisions of article 10 of the WFD, they in unison, express that they as such do live up to the article in their practice. Requirements of emission limit values are not stipulated as a rule. Rather all the water managers express that they require BAT in the permits, a provision they find in the EPA § 3. One of the water managers once again expresses why:

That is basically what we do. I mean the thing about BAT. What is the best technology we know to treat the water and what is the best praxis we know…. But we do not stipulate emission limit values…as a rule. We don't do that, simply because we won't follow up on it, because we can't act anyway.
(R1, Municipality 2)

Through their contemplations it became clear that requirements of sampling emission limit values are only stipulated in certain instances, e.g. when a new technical facility is to be tried out or there is special attention on a discharge because of risk of certain pollutants such as copper. As such, it means that the water managers, in attempting to live up to environmental objectives, stipulate a functional requirement as the best rule – to use one of Giddens' concepts. Whether this *best rule* truly complies with the EQS as stipulated in Order 1022/2010 depends on the water managers' assessment.

4.3 Technologies in practice

In this part I point out how the professionals apply technology in their practice, and how they learn about and assess the optimal solutions in their work. An image of how confident the water managers actually are, when it comes to what BAT is and can be, will be portrayed.
The extracts are somewhat technical and are included to show the different perceptions that exist.

4.3.1 What works - what doesn't

Before having introduced BAT as a subject, two water managers express how it is not a part of their job as authority to be advisors for the discharge and advise the discharge design as such in the application process, but rather provide the conditions for the discharge that the applicants must live up to. They mention how the applicants might find a requirement for a treatments solution in the permit (e.g. an oil separator) expensive, and the dilemma of not knowing when a solution is necessary or not:

R1:It's also something like that that we discuss, is there a bagatelle limit for this, we think it's a bit hard really to clarify. When is it necessary and when is it not necessary, to not make it into an overkill".
R1: Yes, it's also hard for us to know 'what is BAT'? If we don't require that they must monitor the concentrations of the different substances, i.e. requirement of analysis, then we are putting our faith into that they use the best available technology, the best treatment solution.
[…] you might feel that you're not completely sure in your case when you're not exactly an expert in treatment solutions, and what there has been done in terms of research about the different treatment solutions. (R1&R2, Municipality 1)

There seem to be a mutual perception on how efficient some of the treatment solutions used today are:

It's a part of what we trying to have people ((applicants)) do, it's to install sediment traps or wet ponds, where sedimentation can take place. […] The thing with oil separators, we sometimes say it's no use, because there are studies showing there isn't really any oil in them, unless it's from a gas station or something like that. […] if you have an ordinary gravimetrical oil separator, one which is just lowering, those can retrain 100 mg/L or close to, and then you say the others 'coalescence' or 'lamella' they can retain 5 mg/L, but in reality they can't. […] What's important for us by now, is that we get a fairly big grit chamber, where the metals can settle on particle or colloids. (R1, Municipality 3)

The water managers also mention filter-treatment, with layers of lime that can bind metals etc., as a possibility today and as something they have required in permits.

At one municipality, they have had enough resources to have experts test the efficiency of oil separators for them:

We have together with oil separator producers, advisors and our own people and some other knowledgeable, our own advisors, for that matter, had a meeting where we have focused on oil separators..."does it make sense to require that?" And we have come to the conclusion that it's probably more…for fun, there is no one who can unambiguously say that it works. Once again, there has been a lot of measurements done on oil separators and it's been found that no matter which oil separator you have...FIRST FLUSH exceeds the limit values regardless. […] does it then make sense to say to an applicant that you must make such an expensive installation, when we deep down know that it's mostly show off to have it. […] It's a bit hard to say, and the expert knowledge can't give us a clear-cut answer, and as long as they can't we dare not say "don't" ((install an oil separator))". We say, "install them".
R1: It's mostly stormwater wet ponds we are a bit more confident about. (R1&R2, Municipality 2)

The water managers are aware that the field of stormwater treatment and facilities is evolving and they bring up the problematics of the current applied technologies such as oil separators, which are not necessarily perceived as BAT amongst them. Some have scrutinised its use value and despite it being non-optimal, are still employing it. In line with Giddens' duality of structure, these actions mean that they are drawing on and keeping the current technological conditions static, thus reproducing and re-enforcing them over time and space[14]. The lack of proper knowledge on available technologies can be pointed at as the constraining factor and reason for the re-enforcement. The re-enforcement, of non-optimal solutions, can be viewed as an attempt to minimise risk and insecurity in the water managers' praxis. The risk, for the water managers, occurs if they cannot fill the gap in their praxis with another known and widely used technology (Giddens, 1990).

It is clear that stormwater wet ponds that delay the stormwater and allow for sedimentation are perceived as BAT at the moment. But the problem with wet ponds is that they take up space and it is a challenge to find space for them in settled cities - as big cities often are:

R1:I don't think I have made yet made a permit, in which I could stipulate a requirement for wet ponds.
R2: No the general problem here in the city is that there isn't that much space for big wet ponds. So it's very much an issue for us, how shall it be treated before being discharged, according to the requirements we set for the water quality it should live up to right?! (R1&R2 Municipality 1)

[14] The term *space* refers her to a municipal section dealing with discharge permits.

Thus, it is not a solution that can be used everywhere each time. Time constraint is likewise a factor that could influence the decision outcome:

In the end it's an economical balancing one needs to do, which conditions are fair to set? It can be immensely expensive to stipulate a requirement for treatment e.g. and it can also be immensely expensive to delay a permit because there is something they ((the applicants)) don't know because they need to carry on. At the same time it is our role to protect the environment and live up to the law, so there are these schisms now and then, where we are like "ok, what do I do here?!". (R2, Municipality 1)

The cost is considered and seems to be the limiting factor for how far the water manager can go in her stipulation:

Or one would stipulate requirements for different filter solutions, double porous filtering e.g. but we must consider the economy. We can't stipulate conditions, which…yeah it can be a bit difficult sometimes to consider what you get out of it compared to the economy. But we can't stipulate too expensive requirements, so if we could just freely stipulate and we had a big bag of money, one could require treatment of all of it. (R1, Municipality 3)

The issue of economical proportionality comes forth several times during the interviews and the financial aspects seem to be a rational basis in the water managers' assessment. A consideration of which measures are fair to require when one is not certain about the effectiveness. In this sense the water managers seem to face a dilemma between the risk of requiring too much of the applicant and the risk of not requiring enough - possibly a drawback for the receiving water body. Another constraint reveals itself as the factor for re-enactment and re-enforcement of 'useless' outdated technology, namely a tendency of economic constraints, meaning that even if there is knowledge of what BAT is, it is not always employed.

It is interesting how the professionals reflect about a BAT catalogue they could use to look in as tool. A tool perhaps provided by an authority, an expert system, that can be completely trusted, as opposed to descriptions of treatment technology provided by manufacturers:

R2: In terms of the dimension of the wet ponds, if they are properly dimensioned, then it's the best. But it requires space. And then again, depending on what you want to treat. E.g. the case with the copper roof, I'm not sure it would have been the best ((with a wet pond)). But we are not experts on this, so it shouldn't be taken as the only truth. But there are many who think, that it's ((the wet ponds)) the best you can do to a great extent – it's to dimension the wet ponds in regard to the catchment they will drain.
R1: But the Nature Agency doesn't chart guidelines for what BAT is.
R2: No. But there is no catalogue; we don't have a catalogue we can look in.
R1: No, we have been talking about that many times, we would have liked such a catalogue.
(R1&R2, Municipality 1)

Interpreting the above statement trough the Theory of Structuration, we see that the water managers are seeking clear rules and guidelines on BAT, in form of a catalogue, which can ease their work. The rules would be a resource for the water managers, which they can employ in their work. The water managers see weaknesses in the existing structures they work in, and hence seek rules, which in practice will strengthen their work and likewise their work structure. The structure here is obviously the municipality and the environmental section they work in.

4.3.2 Staying updated

A way of assessing how BAT was implemented in the water managers' work was trying to understand how they learned about BAT. As discussed in section 2.2, the term Best Available Technology, as the word *available* implies, refers to the best that is accessible in the present. Thus, it means that the technology for stormwater discharge treatment and delay is an evolving field and must be carefully followed to ensure that up-to-date facilities are implemented every time a discharge permit is given. While it is the water managers' responsibility to ensure that they require BAT in a permit, it seems to some degree out of their competence to assess what BAT can be. This is also why some of them mention that it is not a part of their work to suggest the technical solution per se, but rather make sure it lives up to the conditions they assess are necessary. Nevertheless it requires a good deal of technical insight and experience to be able to 'make sure it lives up to the necessary conditions':

It's not us who are facing the challenge, it is those who need to get rid of the water, they are pretty well updated, and come up with something all the time. (R2, Municipality 2)

Despite the statement, the water managers try to orient themselves in different places, they mention, searching on the internet, technical journals, exhibitions, the yearly pipe days organized by the Technological institute, courses, meetings, *Envina* association of environmental professionals, homepage of the Danish Nature Agency, magazines from producers, using their network, engaging in projects and collaboration with other municipalities.

Even though it is not the water managers who propose the drainage solution, they are aware that new ways of handling the stormwater is necessary to try out if one wishes to gain some new experiences:

R2: Yes, well, the development on this area is going really fast and we need to make sure that we find the best, right. But, what are our preconditions to find the best with something that hasn't been tried out before?
R1: And it's like a dog biting its own tail, because if they are not allowed to install it, then we don't get any experience on what else it can do and then we won't permit it next time and then we won't get any experience.
R2: No, we are obliged to stick our necks out at times, and say that this could be an alternative to this and this and this. Then we must stick our necks out according to our best knowledge and preconditions and the information we can get. However there are no guaranties, they ((the producers)) don't give any guaranties. (R1&R2, Municipality 2)

One of the same practitioners also points out how he proceeds with caution:

We have a lot of possibilities to check it out. […] well, I gladly use money on consulting companies, if I'm facing a problem, where I'll say "this, I won't accept it just like that, I need to know some more". Then I order a report from someone and I say you know what, hold your horse until I'm done figuring this out. (R2, Municipality 2)

But it is also a matter of trusting what the applicants suggests:

But again, we are not supposed to be advisors, so their task is to convince us about the chosen solution, I mean it could be bringing some () similar facilities - then say ((to us)) it is documented that it treats to this and this degree - then we of course believe in that. (R1, Municipality 1)

A similar expression on the dynamic between authority and applicant comes forth:

Then they say "we would like to make this solution, we think it's the best there is on the market", then we say yes to that and tell them to carry out measurements. […] to verify the method.
(R1, Municipality 3)

It is not possible for the water managers to be certain of all the discharge facilities and treatment solutions that exist today. It is out of their competency to properly assess the technology if it has not been tried out for some years. This means they have to find a balance in their assessment. On one hand they are not experts and are not able to do the full assessment themselves, on the other hand they also need to continue their practice of permitting stormwater discharge, as it is in the interest of society. So this results in trusting the functionality of the solution suggested by the applicant. The inflow on knowledge about BAT is not from a higher standing institution. Rather it is often applicants, e.g. utility companies, who bring new technologies to the fore and in collaborative manner water managers decide to test new solutions, to gain new insight about what BAT can be. The collaboration results in either an approval or refusal of the technology.
I view the water managers' collaborative decision-making process, as a structure per se. I do so, because the water managers engage with the applicants in understanding what works and what do not. This is the most apparent pattern of practice happening over time and has become the upheld structure of the way technology is integrated in their management. As such, resources, meaning knowledge about BAT, are drawn from this structure and this repetition goes hand in hand with the concept of 'duality of structure'. Praxes create rules and resources, which are the same as structure, and structure creates practices (rules and resources) (Inglis & Thorpe, 2012).

Some of the water managers mention how they wish that guidelines would be given from the Nature Agency. This institution seems to be perceived as a more trustworthy expert system. This is likely because the water managers view the public institutions as the norm setting impartial actor, whereas they know other actors can have stronger interests in their own agenda rather than the water environment. Yet in lack of the Nature Agency's provision, an alternative experts system must be

chosen to support decision-making and in this context it has become the applicants. As mentioned before this requires a reliance of what the applicants suggests (Kaspersen, 2001). Reliance at times implies risk, but it is seemingly a risk that the water managers must accept, in a pragmatic sense, in order to proceed with the agenda of managing stormwater.

Seemingly the praxis is influenced by a repetitive risk assessment each time the water managers process a discharge application. This especially comes forth during their account on BAT. This is what we see when the water managers claim that they do not know enough about BAT within stormwater discharge, and literally say '*we are not experts'*. To a certain degree, they pragmatically accept their lack of knowledge and instead trust the applicant's suggestion on their choice of discharge facility. Giddens (1990) says that trust operates in risk environments and he propounds that a condition for trust is not the absence of power; rather it is the absence of full information. The absence of full information forces agents to trust in the expert systems as previously described. As such, the knowledgeable applicant becomes the expert, who brings the knowledge, and the water managers, if in lack of knowledge, trust the applicant.

When the water managers reflect on the need of trying out new facilities, because otherwise they will not know if it works or not for future decision-making, it is a way of trusting the abstract systems now, but being reflexive at the same time. For, if useful knowledge can be gained from accepting new technology to be tested, then future practice can be revised for the benefit of the environment. It is a way of stepping out of the traditional routine but it is a risk that apparently must be taken. The water managers are conscience about the limitations of the present technology available, e.g. their ambivalence with oil separators, which is also a product of an expert system. At the same time they are also generally aware of the limitations of the new knowledge that the experts systems bring forth, we see this when e.g. one of the water managers utters 'but *there are no guarantees, they don't give any guarantees'*. The water managers' perception pattern is very much in line with Giddens (1990) who on 'awareness of the limitations of expertise' writes:

"no expert system can be wholly expert in terms of the consequences of the adoption of expert principles" (Giddens, 1990:125).

Hence, it cannot be avoided that elements of hazard or luck come into play when managing stormwater.

5 Discussion

This study originated from the problematic of climate change, expectations of more stormwater in the near future as well as the growing awareness about the complex pollution profile of stormwater and its implications for receiving waters. The general aim with this thesis was to contribute with insight to the current stormwater management in Denmark in order to understand which impediments there might be in the way of achieving environmental objectives of the water environment. After outlining the legal frames, I undertook an analysis of a group of water managers' praxis underpinned by a practice theoretical perspective, viewing agents' recursive actions as upholding the social system within which they figure, and their actions being upheld by the same social system. In so doing, I was able to shed light on the problematics that exist within water managers' assessment of discharge applications as well as the dynamics within their work.

The patterns analysed previously elucidated possible impediments to the achievement of environmental objectives. To start with, the general consent on the lack of environmental data on receiving waters stood out. It can seem as a paradox that the Danish government, while working on the implementation of regulation (water plans) for achievement of environmental objectives, at the same time, cut back on monitoring of water quality, needed for the self-same achievement of those objectives. Andersson et al. (2012), point to a similar issue in a study of local water management in the Oxunda catchment in Sweden. They state *"it is of particular interest to maintain monitoring that has been on-going for periods of time […] to prevent scientifically useful data series from being discontinued or terminated as a result of changes in the institutional environment"* (Andersson et al., 2012:80). This seems to be what has happened in Denmark, after the NOVANA programme, originally a county task, became governmental. Andersson et al. in their qualitative study with Swedish water managers, find their general opinion to be that resource improvements from the county board level to the municipal level are i.a. required to maintain existing long-term monitoring. In line with the above, the water managers in this study expressed how they expect the Danish Nature Agency to provide the needed data and guidelines. Yet there is an indication of institutional inertia, on levels higher than the municipal, as the situation is now for stormwater management. Lack of environmental data does not seem promising for the practice of municipalities, when they have to balance stormwater discharge with the environmental status and objective of the municipal water bodies. The decreased monitoring, as a result of governmental decision-making, indicates a relaxed approach to the overriding goals of the WFD and a slow process towards giving stormwater discharge, and its adverse impact abilities, the attention and priority that is truly needed. As the WFD stipulates cyclic management processes there is possibilities for what could not be lived up to in terms of environmental objectives can be improved in the next cycle, and possibly more attention will be given to the impact of stormwater and the data needed to regulate this field properly. However, Denmark is already behind in achieving the goals of the first WFD cycle ending in 2015, as the water plans have still not been enacted. This creates a doubt of whether there will be a focus and concrete measures for stormwater in the next round, or more 'visible' pollutants such as CSO or the agricultural sector will keep the attention. Looking to neighbouring country, Sweden, concrete measures on stormwater management are also missing in Swedish programmes of measures, thus sustaining a loose stormwater management for now

(Söderberg, 2011) which can be problematic for achievement of environmental objectives likewise in Sweden.

As this study did not specifically aim to discover the reason for cuts in monitoring, only a surmise can be made about the reason. The classical assumption seems to be economic savings and, as a more general perspective, it is interesting to investigate the proper reason it as there is no doubt that a weak scientific basis can hinder compliance with the goals of the WFD. Denmark is already behind with compliance and Baaner (2012) indicates that political economic prioritisation has lead the Danish government to mistakenly use the argument of 'lack of knowledge' on the status of water bodies or needed restoration measures as a reason to delay the enactment of water plans, thus compliance with objectives. However, according to the WFD, 'lack of knowledge' is not a valid reason for postponement of the compliance deadline (ibid). Before us, a complex picture appears, which shows how the landscape of water management is influenced by many factors and despite a strong EU regulative, tangible measures needed to further regulate the stormwater management and place it on the agenda are but slowly on their way. As described earlier, applicable data on the pollution profile of urban runoff or substantial environmental data on receiving waters seem neither to be available to water managers. This has created a praxis where a technological treatment or delay facility is required in discharge permits, but requirements for emission limit values for the drainage water is not set. The problematic lies in the fact that the water managers also doubt the technological facilities at hand. As well as not always being able require what they perceive as BAT because of cost or space demands. Söderberg (2011) finds in a study on Swedish stormwater management, that besides the lack of knowledge and data on the environmental impact of stormwater, an impediment for modern solution in the stormwater management is the economical aspects, as sustainable stormwater solutions are costly and technically demanding. A finding in line with the narratives of the water managers who expressed the obligation of balancing requirements in a permit with the final cost for the applicant. This is an indication of a common administrative impediment, which is not unique for Danish municipalities. Turning back to the environmental impact of stormwater Ingvertsen (2011b) points to the difficulties in predicting the highly variable nature of the urban runoff pollutant profile. He suggests that whether theoretical or monitoring approaches should direct the future SUDS planning and development in Denmark, a rational way forward would be an agreement, amongst experts, on acceptable levels of uncertainty with regard to the existing knowledge about urban runoff pollutant profiles. Ingvertsen also points to the need of developing a set of guidelines for appropriate sampling of urban runoff in order to enable professionals to include potential uncertainties in their evaluations and planning of SUDS - as there is a need of improved transparency of present and future monitoring results. A more uniform praxis, in Denmark, in terms of sampling, monitoring and integration of uncertainty of the pollutant profile could advance the work of all water managers, and specifically those who presently through their social capacity building activities, attempt to increase their knowledge about the pollutant profile of urban runoff.

As explained above water managers do not stipulate requirements for sampling in discharge permits, meaning that they stipulate the first term of WFD Art.10 (requirement of BAT), but not the second (requirement of emission limit values), unless it is a special case. This means that the condition of control through emission limit values of WFD Art. 10 fall out of their praxis. If the water managers

wished to follow the guidelines of Order 1022/2010 to ensure a water bodies EQS, it would either require that the treatment facility chosen for the discharge could truly live up to emission limit values, in accordance with the set EQS, or the water managers would ensure that sampling of the discharge water took place – again to check compliance with EQS. However, requiring the applicant to sample in order to follow up on emission values seems not to be the general case. This situation has indicated that in terms of living up to a receiving waters' EQS, stormwater discharge is not the practice that is strongly regulated for the purpose. In his discussion of environmental law, Goldblatt (1996) argues that in the actual world of pollution regulation, the reason for legislation not translating into decreased levels of pollution is because no environmental regulatory agency has the funding or staffing to properly carry out its responsibility. He states: *"They are often unable to take regular measurements of pollution emissions or to conduct detailed environmental impact assessments. Nor are they usually able to obtain the necessary information to form any kind of judgment without the co-operation of the company concerned".* (Goldblatt, 1996:185). He also propounds that because companies are concerned with the cost of pollution regulation, environmental agencies must balance the economic costs of pollution regulation with environmental benefits. He further states: *"In UK this has actually been codified in the somewhat clumsy notion of 'best environmental practicable' option not entailing excessive cost"* (Goldblatt, 1996:185). Even though it is not indicated whether Goldblatt's arguments are all empirically based, his discussion underpins the finding of this study. Lack of resources to carry out sampling, mutually deciding the technological facility, suggested by the applicant, and the obligation of considering the cost of the requirements are all elements that came forth as constraint in the water managers' praxis. Moreover, it seems that Goldblatt's statement on *"best environmental practicable option not entailing excessive cost"* falls not very far from how the legal decision support system *Schultz* - with guidelines for authorisation of permits - suggest case handlers to beside doing an assessment of environmental objectives and the water bodies sensitiveness, likewise ensure the choice of a 'cost-effective technical possibility' (Schultz, 2014).

Dalberg-Larsen (2005) writes that the problem is when those who shape the laws wrongly believe that practitioners who are not lawyers would apply laws, as lawyers would do. Without considering the applicant of the law, 'communication problems' can occur. But on the other hand, he says, non-lawyers are often able to find good and rational decisions, on the basis of their own preconditions. The problem is then that the law does not function as originally foreseen by those who made it (ibid). This can mean that even though Statutory Order 1022/2010 in its preamble integrates EU directives, including the WFD, making the listed EQS in Order 1022/2010 binding for municipalities when issuing stormwater permits - they do not necessarily follow the achievements of the given EQS to the detail. Instead, in their praxis they apply the provision of BAT, when issuing a permit, which is also stipulated by the same law, but there is an uncertainty degree to the use of BAT as there is no consistent monitoring of the discharge treated through the BAT - the technical facility. In order to stipulate other requirements such as emission limit values as part of reaching EQS there is – interpreted from Giddens' perspective – a need of other 'rules', such as proper guidelines from the Danish Nature Agency, as well as more substantial environmental data. Only then can it become a part of the water managers' praxis. Until then, the water managers' rational choice is functional requirements in permits. Ingvertsen (2011b) argues that regardless of the approach and level of emission limit values, the overall compliance with EU goals will be difficult to evaluate during the first coming years until a

revised national monitoring programme has been running for a number of years. What can be done, according to Ingvertsen, is for authorities, for a period of 5-10 years, to define case specific emission limit values for each SUDS employed in order to use the data to gain sufficient experience and documentation regarding the treatment efficiency of a range of SUDS to enable implementation of design criteria (BAT) - which ensures emission limit values in compliance with the given EQS. Besides the process of benchmarking technologies, which as Ingvertsen suggest, can take years, it is important that current stormwater discharges are monitored, to see if they hinder water ways' compliance with goals. If they do actually hinder compliance, a proper measures shall be set for current and future discharges in the future water plans.

The use of a practice lens, in this study, focused the attention on the water managers' perception of BAT, and how they learn about BAT, in their ongoing situated activities. Like Orlikowski (2000), I discovered some patterns of technology enactments in the water managers work structure. Firstly, they brought up the problematic of low-tech facilities such as oil separators, which was not necessarily perceived as BAT amongst them. Some of the water managers had scrutinised its use value and despite it being non-optimal, were still employing it. This type of enactment, Orlikowski terms *inertia*. Inertia is drawing on and not changing current technological conditions, thus reproducing and re-enforcing them over time and space. Moreover, many of the water managers mentioned wet ponds as BAT within stormwater management, yet also pointed to the problem of its space demands, rendering its use impossible in some cases – especially in dense cities. Bäckström et al. (2002) questions whether wet ponds are actually BAT. Bäckström et al. point to the risk of acute effects on the ecosystem in the receiving water because of the possibility of escape of dissolved substances and re-mobility of pollutants trapped in sediment of the wet pond. On the other hand Vollertsen et al. (2012) propounds that one of the most well documented technologies within stormwater management are wet ponds and if properly dimensioned, and maintained, wet ponds can substantially decrease the impact of stormwater on the receiving water (ibid). Despite the discrepancy in perceptions about wet ponds, both Bäckstrom et al. and Vollertsen et al. agree that technologies with a higher degree of treatment are filter based technologies, something that some of the water managers also bring forth. However, it is not a technology that is widely applied yet. Until now it appears that wet ponds have become a deeply rooted element in the Danish stormwater management since the water managers perceive it as BAT. What supports this rootedness is the reference that the Danish Ministry of Environment, in the water plans, makes to a more than 20-year-old report, on the design of wet ponds- something that Baaner (2013) also deem peculiar. It can be questioned whether no advancement has happened in the last 20 years and why no updated guidelines has been created by the Ministry. In the light of Giddens' Theory of structuration, The Ministry of Environment is as such possibly upholding old rules as part of the stormwater structure. It is likely that these rules will likewise be upheld by the water managers, using the water plans as an administrative basis, when they are finally enacted. There are 98 municipalities in Denmark; it is possible that some water managers will follow an outdated report if better guidelines are not available to them.

Another constraining factor in choosing BAT appeared as the cost of the requirements set in a permit. An economical balancing is done for each permit assessment. Allison et al. (2008) found the uncertainties in performance and cost as well as insufficient engineering standards and guidelines as

some of the impediments to SUDS implementation. An additional question, in this discussion, is whether it is the cost of the technology that hinders its use and possibility to become BAT or it is the uncertainty about its performance. They seem to be mutually constraining factors. Allison et al. believe that with the increase of SUDS implementation the cost of the technology will decrease and become more accepted in institutions.

The second consistent enactment pattern revealed that the inflow of knowledge about BAT is not from a higher standing institution. Rather it is often applicants, e.g. utility companies, who bring new technologies to the fore and in collaborative manner water managers decide to test new solutions, to gain new insight about what BAT can be. An enactment pattern Orlikowski (2000) terms *application.* However, a balance must also be created between what private companies like utilities contribute with, as these companies' incentives often lean more toward service and profitability than environmental management per se. Governmental agencies do not have the same incentives as private companies and it is therefore important that knowledge also equally flows from these institutions and become decision basis for water managers. Sufficient performance standards and guidelines on SUDS facilities can always become better and be of help to water managers in their decision-making (Allison et al., 2008). Nevertheless, as also indicated above Ingvertsen (2011) found that a proper benchmarking of technologies for stormwater is not straightforward as there is a lack of uniformity in available data on urban runoff pollutant profile. An indication of the field of stormwater management as an evolving field, which is faced by the large volumes of water to be managed and the variable character of the pollutant profile (Fryd et al., 2012).

This study did not aim to indicate BAT within stormwater management; rather it has contributed in shedding light on the complexity of performing a best management practice. The praxis analysis through Giddens' theories has aided in elucidating the emerging field, where risks are taken, experts trusted and reflexivity is the pre-requisite to bring new knowledge to the structure - allowing change of rules of the current practice.

By analysing the empirical data, after conduction of interviews, my own understanding of the situation naturally became enhanced – very much in line with the hermeneutic cyclic process, an iterative back and forth process between the parts and the whole (Kvale & Brinkmann, 2009). During the data processing, it led to reflections on what I would have asked the respondents as follow up question had I possessed the improved understanding during the interviews. As an example I would have liked to pose more direct questions on which waterways they have with fixed environmental objectives – which also receive stormwater. The answer could have been that they do not have any. Municipalities number 1 and 3 indicate that they do not operate with new environmental objectives or that the objectives are postponed as a result of the water plan postponements. However, if I had acquired a name on the waterways with environmental objectives, at each interview, it could have pointed out the problem I was investigating in a stronger manner. One can say, this is a limitation of engaging just once with respondents. As such, one must rely on a single round of interpretation. However, it is also a good illustration of how creation of meaning and knowledge, in a qualitative approach, is a continuous process - spanning from the beginning of the research until the last full stop has been made (Järvinen & Mik-Meyer, 2005).

Prospectively, it would be interesting to study whether there will be a stronger focus on stormwater discharge in the Danish water management. This should be done in the light of the future water plans to be adopted, and especially the water plans that shall be enacted after 2015. A study of how stormwater discharge will be managed in future water management plans, e.g. the future municipal water-action plans as well as climate adaptation plans when they become enacted, in order to gain a better understanding of the role of stormwater discharge in the on-going compliance process of environmental objectives. This study has provided the broader picture, thus a good way of following this field in the future would be through a case study of one or two municipalities. More specifically a study that examines a municipality's work with achievements of environmental objectives, in details, in connection to choices made for stormwater management. A future praxis analysis can shed light on whether the praxis will change as there will be more focus on the stormwater problematic, when the effects of climate change and plans of mitigation will become more prominent. Also another look into how the field of BAT and measurement methods evolves will be a logic continuation of this study.

6 Conclusion

The general aim of this thesis was to through a practice theoretical perspective contribute with insight to the current municipal stormwater management praxis in order to understand which impediments there might be in the way of achieving environmental objectives of the water environment. It was found that municipal water managers operate with a broad range of regulations, as stormwater management is both regulated on a planning and an environmental level. The WFD itself is not utilised, but national regulation such as the Environmental Objectives Act and water plans are employed in the praxis. In attempting to live up to environmental objectives, the water managers stipulate a functional requirement in discharge permits. Whether this paradigm truly complies with the EQS needed to achieve a receiving water's environmental objectives depends on the water managers' best judgement. For, as long as the water managers have to consider the cost of the discharge facility, impracticality of sampling and are, at the same time, constrained by a general lack of environmental data series on receiving waters and knowledge of the runoff pollutant profile; requirements of emission limit values, with the purpose of meeting EQSs, can not easily become a part of their working structure.
The cost of a discharge project acts as a rationale basis, for the water managers, in their assessment of a permit. The water managers consider which measures are actually fair to require when they are not certain about the effectiveness. In this sense, the professionals seem to face a dilemma between the risk of requiring too much of the applicant and the risk of not requiring enough, thus being a disadvantage to the receiving water body.

The perception of BAT is, among water managers, wet ponds, yet wet ponds are not always applied as the solution because of its space demands. The water managers have taken on a collaborative approach in choosing the technical facility for the concrete discharge, which the applicant is the one to suggest. With interpretation through the chosen practice theory, it became clear that the water managers, by collaborating with applicants, are being reflexive as they wish to bring new knowledge about technology to their practice. In so doing, they are obliged to trust in the experts systems, the applicants, but it is a risk they take in order to gain experiences and change the conditions they work under today. The collaboration is the most apparent pattern of practice happening over time, and embedded into space – the respective environmental section - and has become the upheld structure of the way technology is integrated in their management. As such, the definition of BAT is a social construct rather than a given guideline from institutions on higher levels than the municipal.

As the situation is today, there is a pressure on the water managers to assess stormwater discharge in terms of their own best competence, instead of clear guidelines provided by e.g. the Danish Nature Agency. Looking back at the general introductory aim, this study has shown that the impediment to the achievement of environmental objectives are the weak environmental data basis, the insecurity about what technological measures can perform and the lacking guidelines from a higher institutions on the pollutant profile of stormwater. The grey zone within which the water managers operate has made them create social learning systems, where they share knowledge and experience with other professionals. As such the water managers are constrained, but seek to improve their competences to advance the foundation of their praxis.

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Appendix 1

Short introduction to the urban sewer system

In Denmark there are three types of urban sewer systems as listed:

1. **Wastewater sewer:** Sewer pipes only for sanitary- and industrial wastewater. Wastewater from this system is directed to wastewater treatment plants, treated and then led to receiving waters.

2. **Stormwater sewer:** Stormwater kept in separate pipes and not mixed with wastewater (sanitary water), not even in case of overflow. In general stormwater from this system is discharged to receiving waters. For some of the outlets, which exist in Denmark today, there are wet ponds and oil separators for delay and treatment before final discharge, but not for all. Besides delaying the water quantities to avert hydrological stress on the receiving water, wet ponds can also allow for sedimentation of solid particles. They can be either underground or placed on the surface as both natural- and artificial lakes. In case of storm, overflow can happen into receiving waters without delay or treatment.

3. **Combined sewer:** A sewer intended to serve as a sanitary sewer and a storm sewer, or as an industrial sewer and a storm sewer. A control device in the sewerage system leads the combined water to a treatment plant before final outlet to receiving waters.
In periods of storms the control becomes overwhelmed allowing overflow of untreated water into receiving water bodies, i.e. combined sewer overflow (CSO). This happens from overflow basins, which are located in proximity to the combined sewer systems on select localities. The basins receive the surplus wastewater, which the sewer system lack capacity for in periods on heavy rain, in order to avoid holding back of wastewater on terrain level. The wastewater from the overflow basins is led directly to a designated watercourse.
About half of the sewerage systems in Denmark are combined systems (DANVA, 2006).

According to a 2004 report there were 5,100 overflow basins for combined sewer overflows and 9700 stormwater discharge outlets in Denmark. In 2001, a total of 186m m^3 of stormwater was discharged through stormwater outlets, of which 70 % was led to streams and lakes (Battrup-Pedersen et al., 2004).

Appendix 2

Short introduction to SUDS

SUDS stand for Sustainable Urban Drainage System. SUDS are sequences of water management facilities designed and constructed to delay and limit runoff flow from a respective area in order to reduce the load on the sewer system (Københavns Energi, 2011; DANVA, 2006). Additionally drainage by SUDS can provide a more green approach than the conventional practice of routing run-off directly through the sewage system (see figure I). SUDS facilities are principally based on retention and infiltration of stormwater (Backhaus & Jensen, 2010). In the urban landscape SUDS functions can be:

- ***Delay****:* Urban runoff is channelled to the sewerage system, but is delayed on the respective private property.

- ***Drainage to a water body***: Urban runoff is on the surface channelled to the nearest lake, stream or coast.

- ***Evaporation of stormwater***: E.g. by the use of green roofs which absorb rainwater.

- ***Infiltration***: Urban runoff is channelled to fascines or rainwater bed and infiltrates to the groundwater.

SUDS can have different design e.g. as:

- Permeable surfaces;
- Filter strips;
- Filter and infiltration trenches;
- Swales;
- Detention basins;
- Underground storage;
- Wetlands;
- Wet ponds, also referred to as basins.

Figure I. Examples of SUDS delay facilities (LAR i Danmark, 2014).

Appendix 3

Concepts in Giddens' 'duality of structure'

Overview of the concepts of the 'duality of structure' as propounded directly by Kaspersen (2001) and Giddens (1984):

- **Rules:** Shall be broadly understood as those techniques and formula that embedded in our unspoken practical consciousness are applied in the action/practice. Among rules that are not just discursively formulated but are formally codified, meaning in written form, are laws (Giddens, 1984).

- **Resources:** The concept of resource is closely tied to power as the medium, through which the agent can exert his 'transformative capacity'. In other words resources are also the authoritative status one has. Resources can also be allocative resources: objects, material goods etc. (Giddens, 1984).

- **Structure(s):** Rules and resources, or sets of transformation of relations, organized as properties of social systems. Structure can also be understood as being made up of agents' practices as these occur over time (Inglis & Thorpe, 2012).

- **System(s):** Reproduced relations between actors or collectivities, organized as regular social practices.

- **Structuration:** Conditions governing the continuity or transmutation of structures, and therefore the reproduction of social systems.